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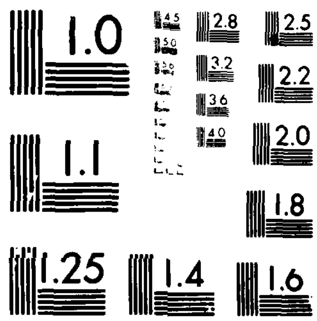

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Report No. FAA-RD-79-116

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LEVEL II

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ATARS/ATC SIMULATION TESTS WITH SITE ADAPTATION LOGIC IN THE PHILADELPHIA TERMINAL AREA

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FINAL REPORT

MARCH 1980

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16. Abstract

The purpose of this project was to provide further evaluation and refinement of the Automatic Traffic Advisory and Resolution Service (ATARS) concept. The tests were conducted at the National Aviation Facilities Experimental Center (NAFEC) at Atlantic City, New Jersey, using the Air Traffic Control Simulation Facility (ATCSF). Test results indicated that ATARS had no significant impact on the controllers or control procedures in a Philadelphia Terminal Control Area (TCA) environment. Outside the immediate TCA, where the majority of encounters occurred, the factors contributing to the generation of alarms were, in general, satellite operations and the use of Visual Flight Rules (VFR) separation criteria. The incidence of positive resolution advisories was low, averaging only 0.5 encounters per hour.

Recommendations are to reduce the size of the ATARS desensitization zone at the Philadelphia main airport to approximately 2.0 nautical miles (nmi) from runway thresholds, to incorporate a convergence/divergence detection filter into the ATARS algorithm, and to investigate the possibility of reducing tracker lag by improving turn and leveloff detection.

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METRIC CONVERSION FACTORS

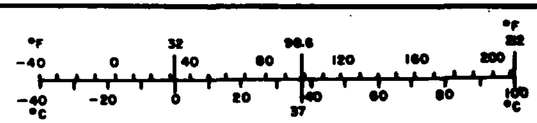
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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INTRODUCTION

PURPOSE.

The purpose of this project was to provide further evaluation and refinement of the Automatic Traffic Advisory and Resolution Service (ATARS) concept. This report presents the results of a series of real-time simulation tests conducted to evaluate the performance of a recently improved ATARS algorithm in the Philadelphia Terminal Radar Control (TRACON). Specific objectives were to determine:

1. The impact of ATARS on the controller and Air Traffic Control (ATC) system in a terminal control area (TCA) environment;

2. The requirement for further desensitization of ATARS in a mixed environment of primary and satellite airport TCA operations;

3. ATARS alarm type, frequency, duration, and location in the terminal area; and

4. A characterization of proximity advisory activity among aircraft in the terminal area.

BACKGROUND.

This effort represents the third set of tests conducted at the National Aviation Facility Experimental Center (NAFEC) to assess the performance of the ATARS algorithm during its evolutionary development. Report No. FAA-RD-76-193 (reference 1) documented the results of a dynamic simulation in the Air Traffic Control Simulation Facility (ATCSF) at NAFEC. The simulation was conducted from May 1975 through September 1975, to investigate the original Intermittent Positive Control (IPC) algorithm. The acronym, IPC, was subsequently changed to ATARS. Report No. FAA-RD-78-138 (reference 2) documented the results of tests conducted in the ATCSF from December 1977 through April 1978 to assess modifications to the algorithm based on recommendations from the 1975 report. These recommendations included alarm threshold reductions and new desensitization logic designed to reduce the number of undesirable alarms experienced in the 1975 study.

The current series of tests was performed from May 1978 through October 1978 and investigated the ATARS algorithm in the Philadelphia TCA. Site-adapted desensitization logic was specifically designed to eliminate interaction between arrival aircraft on converging Instrument Landing System (ILS) courses close to the airport and between ILS and airport surface traffic. The Philadelphia area was selected for several reasons. Primarily, Philadelphia has been designated as the locale where pre-operational trials of the Discrete Address Beacon System (DABS)/ATARS engineering model will be performed. In addition, the Philadelphia TRACON facility is responsible for the control of a number of satellite airports which provide a unique, complex, operational test environment. It is a major hub in a series of east coast hub terminals; as such, it is an ideal site for future multi-site DABS/ATARS testing.

DISCUSSION

TEST ENVIRONMENT.

The testing used the real-time ATCSF at NAFEC in a stand-alone configuration. This facility consists of an ATC laboratory, a simulator pilot laboratory, an ATARS simulator, and a target generator. The target generator causes all aircraft to fly in accordance with flight plan inputs. Controller personnel modify the flightpaths of controlled aircraft through a voice link to simulator pilot positions. Keyboard entries by the simulator pilots cause the target generator to respond to the control instructions. All aircraft automatically respond to ATARS commands which are transmitted to the target generator via a simulated uplink. The controller may at any time override the ATARS command by simply instructing the aircraft to do otherwise. As a result, the controller maintains control of the aircraft under his jurisdiction at all times.

The test environment simulated a single DABS sensor site serving the Philadelphia TRACON facility. Testing was accomplished utilizing the ATARS algorithm provided by the MITRE Corporation (reference 3) with new site-adaptation logic incorporated (reference 4). Desensitized zones were designed by NAFEC specifically for the Philadelphia airport. In general, these zones were defined about the ILS approach courses and extended from the end of the runways to the outer markers. In addition, they extended to 500 feet above the runways. Within these zones, ATARS would not issue threat or resolution advisories to either aircraft established on the ILS or aircraft on the airport surface. The intent of these zones was to eliminate undesirable ATARS alarms to aircraft on converging ILS courses and between arrivals and surface traffic. Further details of the desensitized zones are described in a later section of this report.

The simulated ATC facility consisted of 13 ATC control positions; north and south feeder control, Philadelphia local control, Philadelphia satellite local control, visual flight rules (VFR) feeder control, north and south approach control, north and south departure control, north and south satellite control, Philadelphia final control, and the TCA control position. Variations of this arrangement were made to support the various tests, and certain liberties were taken in combining certain positions and controller work assignments due to a limitation in the number of available test controllers. In general, the Philadelphia TRACON operation was faithfully simulated.

Five satellite airports were simulated. These were North Philadelphia (PNE), Trenton (TTN), Coatsville (CVE), Willow Grove (NXX), and Greater Wilmington (ILG). Typical traffic flows in the terminal area are shown in figures 1 and 2.

The arrival flows are shown by dashed lines and the departure flows are indicated by solid lines. No satellite traffic flows are shown. In general, satellite operations represent a highly coordinated effort wherein the satellite controllers direct their aircraft in a way to avoid much of the Philadelphia airport traffic. The locations of satellite airports around the TCA tends to

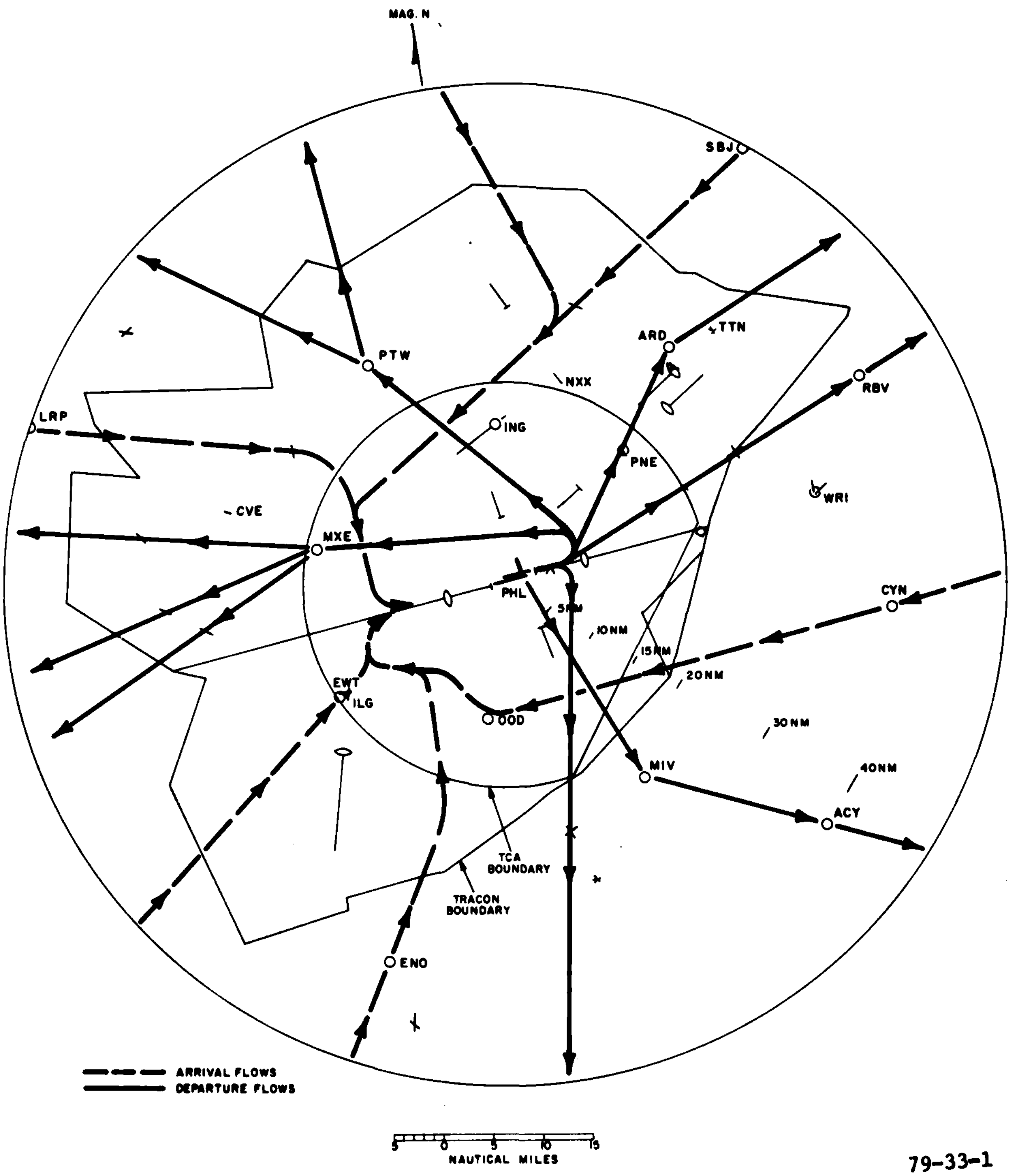

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FIGURE 1. EAST TRAFFIC FLOW TO PHILADELPHIA INTERNATIONAL AIRPORT

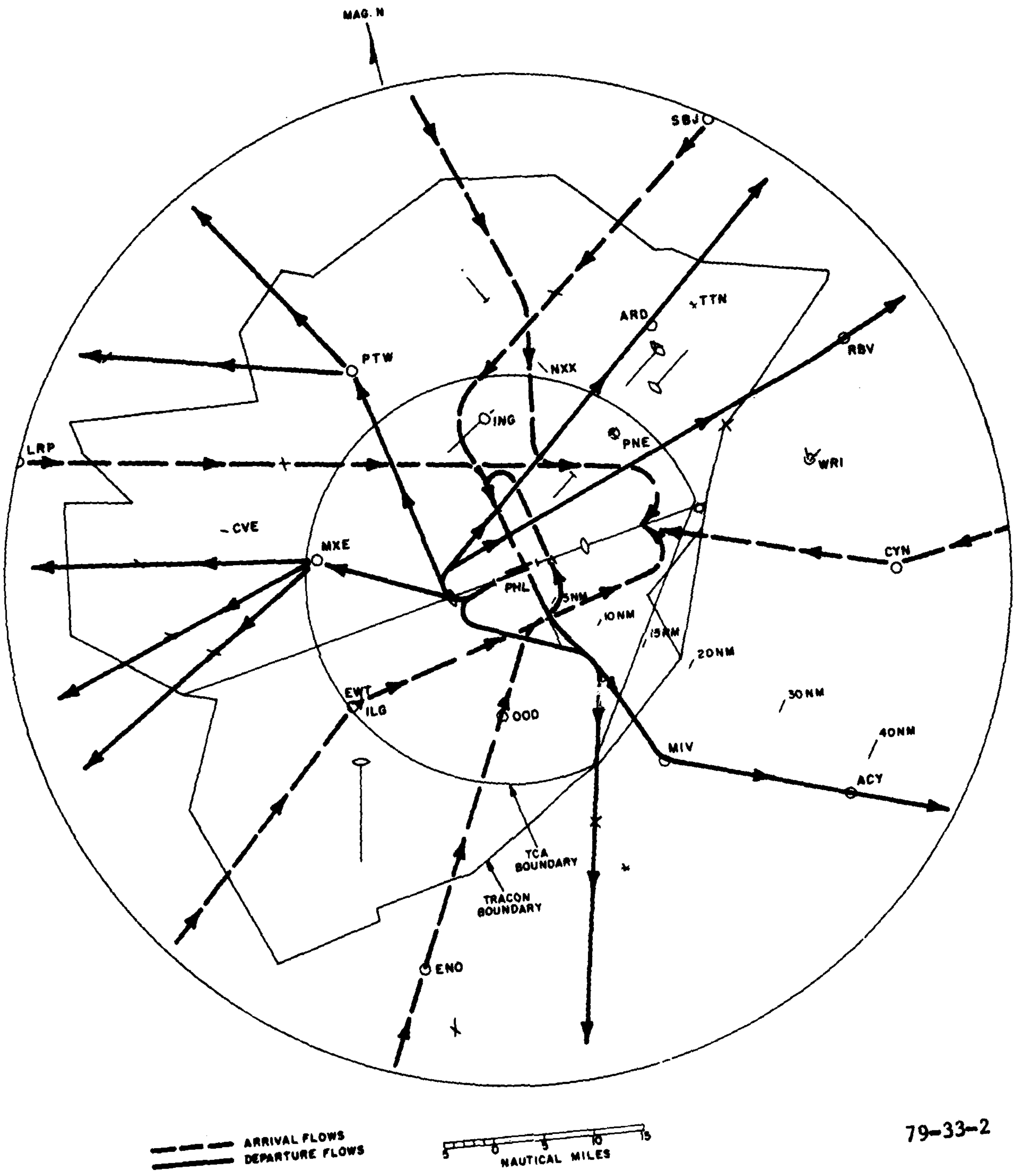

FIGURE 2. WEST TRAFFIC FLOW TO PHILADELPHIA INTERNATIONAL AIRPORT

naturally create crossing route situations with the main flow of traffic. The terminal area included all traffic within a 50-nautical mile (nmi) radius of the center of the Philadelphia airport.

TEST SERIES--GENERAL.

Four series of tests were conducted. Each series consisted of four 1-hour and 15-minute simulation runs. The first 15 minutes of a run were used for traffic buildup and the last hour as the data base. The test series was established for two purposes; (1) to assist in familiarizing the controllers with the environment by studying first the Philadelphia airport and then increasing to satellite airports and greater traffic density, and (2) attempting to isolate the sources of ATARS activity to single airport versus multiple airports and instrument flight rules (IFR) standards versus VFR standards. The test series is identified as follows:

1. Philadelphia airport only, IFR separation = PI,
2. Philadelphia airport only, IFR/VFR separation = PIV,
3. Philadelphia airport plus satellites, IFR separation = PSI, and
4. Philadelphia airport plus satellites, IFR/VFR separation = PSIV

In each of the four test series, all aircraft, whether IFR or VFR, were controlled by ATC. Futhermore, all aircraft were DABS equipped which means that the aircraft are equipped with ATARS and an altitude reporting capability.

TEST SERIES PI--ALL DABS.

This series simulated the Philadelphia airport in a purely IFR situation. The traffic sample density was 75 DABS equipped aircraft per hour. It was assumed that all aircraft were operating under IFR conditions.

TEST SERIES PIV--ALL DABS.

This series duplicated the trafic samples used in the PI series, except that 50 percent of general aviation and air taxi aircraft were operating under VFR. The remaining aircraft were operating under IFR.

TEST SERIES PSI--ALL DABS.

This series introduced satellite operations, and all operations were IFR. The Philadelphia airport hourly rate was 75 aircraft, but 42 satellite aircraft and 2 overflights were added.

TEST SERIES PSIV--ALL DABS.

This series was a mixed IFR/VFR environment with approximately 50 percent of the population operating under VFR conditions. Sample density was the same as series PSI except that seven VFR overflights were added. An overflight is defined as a flight which does not takeoff or land in the Terminal Radar Service Area (TRSA).

SPECIAL TESTS.

In addition to the four test series, two special tests, non-mode C (NMC) and uncontrolled (UNC), were performed. The first, NMC, was made to study the interaction between ATARS equipped aircraft and non-mode C aircraft when ATARS issues commands to equipped aircraft. The second, UNC, was run to investigate the interaction between controlled and uncontrolled ATARS equipped aircraft operating in proximity to a TCA.

The NMC run is identical in aircraft density to the PSIV series, but a quantity of ATCRBS non-mode C aircraft, which are not recognized by ATARS, are introduced. Since ATARS is not aware of these aircraft, no ATARS advisories or controller alerts are provided when they are in potential encounters. Altitude information on these aircraft was not displayed to the controller. All the air carrier and air taxi aircraft are DABS equipped. For the general aviation aircraft, 20 percent are DABS equipped, 20 percent are ATCRBS mode C equipped, and 60 percent are ATCRBS mode A equipped.

The UNC run is identical in controlled aircraft density to the PSIV series. Twenty-five uncontrolled VFR DABS aircraft are added and programmed to fly in close proximity to the TCA area. The only responsibility the controller had for these flights was to issue, as necessary and workload permitting, traffic advisories to controlled aircraft. All aircraft are DABS equipped.

SEPARATION CRITERIA.

IFR separation criteria used by the controllers was a minimum of 1,000 feet vertical or 3 nmi horizontal. ATC separation used under assumed VFR weather conditions was 500 feet or 1.5 nmi between IFR/VFR, and VFR/VFR aircraft, and 1,000 feet or 3 nmi between IFR/IFR aircraft. Because of wake turbulence, aircraft were separated from heavy jets by 4 nmi when a heavy jet was behind a heavy jet, and by 5 nmi when a small or large aircraft was behind a heavy jet. These separations were applied to an aircraft if it was operating directly behind a heavy jet at coaltitude, operating directly behind a heavy jet and less than 1,000 feet below it, or if following a heavy jet and conducting an instrument approach. In addition, for landing aircraft, a small aircraft behind a large aircraft required 4 nmi at the time the preceding aircraft crossed the threshold. A small aircraft behind a heavy aircraft required 6 nmi.

TRAFFIC SAMPLES.

The construction of the traffic samples was based on an analysis of flight progress strips. Since the Philadelphia TCA has no specific entry fixes published for VFR aircraft, the entry points used for these traffic samples conformed to the normal IFR traffic flow without deliberately mixing with that flow and reflected a consideration for the high level of experience to be found in Philadelphia pilots. The construction of the uncontrolled traffic sample was based on information derived from VFR flight plans obtained from the North Philadelphia flight service station. More detail on the traffic samples can be found in appendix A.

ATARS ALGORITHM.

The ATARS algorithm used during these ATCSF simulations is a modified version of the original IPC algorithm (Report No. FAA-EM-74-4, change 2). The principal modifications to change 2 include;

1. A uniform detection logic was employed; i.e., controlled and uncontrolled aircraft were treated in the same manner with respect to the detection of conflicts and the issuance of commands.

2. The generation of a Flashing Proximity Warning Indicator (FPWI) or a command would force the generation of a controller alert.

3. ATARS final approach desensitization zones were specifically adapted to the configurations of the Philadelphia runways.

A brief description of the ATARS algorithm and the types of messages generated by ATARS for delivery to pilots and controllers is presented in appendix B.

ATARS DESENSITIZATION.

Previous testing had demonstrated the need for desensitization of ATARS around the airport and its approach courses to eliminate undesirable alarms between airborne and surface aircraft. This also prevented unnecessary alarms between aircraft on parallel approaches. In earlier NAFEC tests, this desensitization took the form of a rectangular volume of airspace about the ILS course(s) within which the ATARS FPWI and command functions were inhibited. Under normal conditions, this method was adequate; however, as indicated in reference 2, improvements were made to minimize the size of desensitization areas while maximizing ATARS protection.

For the Philadelphia study, the size of the desensitization zone was reduced based on the attributes of the environment. Although there are parallel runways at the Philadelphia airport, the separation between the runways does not meet the requirement for parallel simultaneous approaches. For single aircraft ILS intercepts, it was felt that a desensitized zone beginning at the outer marker and extending to the airport would be adequate. Additionally, providing this area of coverage to the surface at the outer marker was considered unnecessary. Consequently, the desensitized zone was designed to be as shown in figures 3 and 4 with a rectangular sleeve of airspace allowing for 200 feet vertical and 0.5 nmi horizontal deviation about the ILS glide slope. To further protect aircraft which are established on the ILS from non-ILS intruder aircraft, an aircraft heading check was incorporated. Aircraft within the desensitization zone whose heading deviated by more than 10 degrees from runway heading were candidates for ATARS FPWI or commands. This was done to protect against aircraft crossing the ILS courses. In addition, an aircraft, even though established on the ILS course within the desensitization zone, was eligible for ATARS service if involved in an encounter with an unequipped intruder. Figures 3 and 4 represent the two operational configurations normally used at the Philadelphia airport; i.e., west for VFR use and east for IFR use. Although both desensitization configurations would be

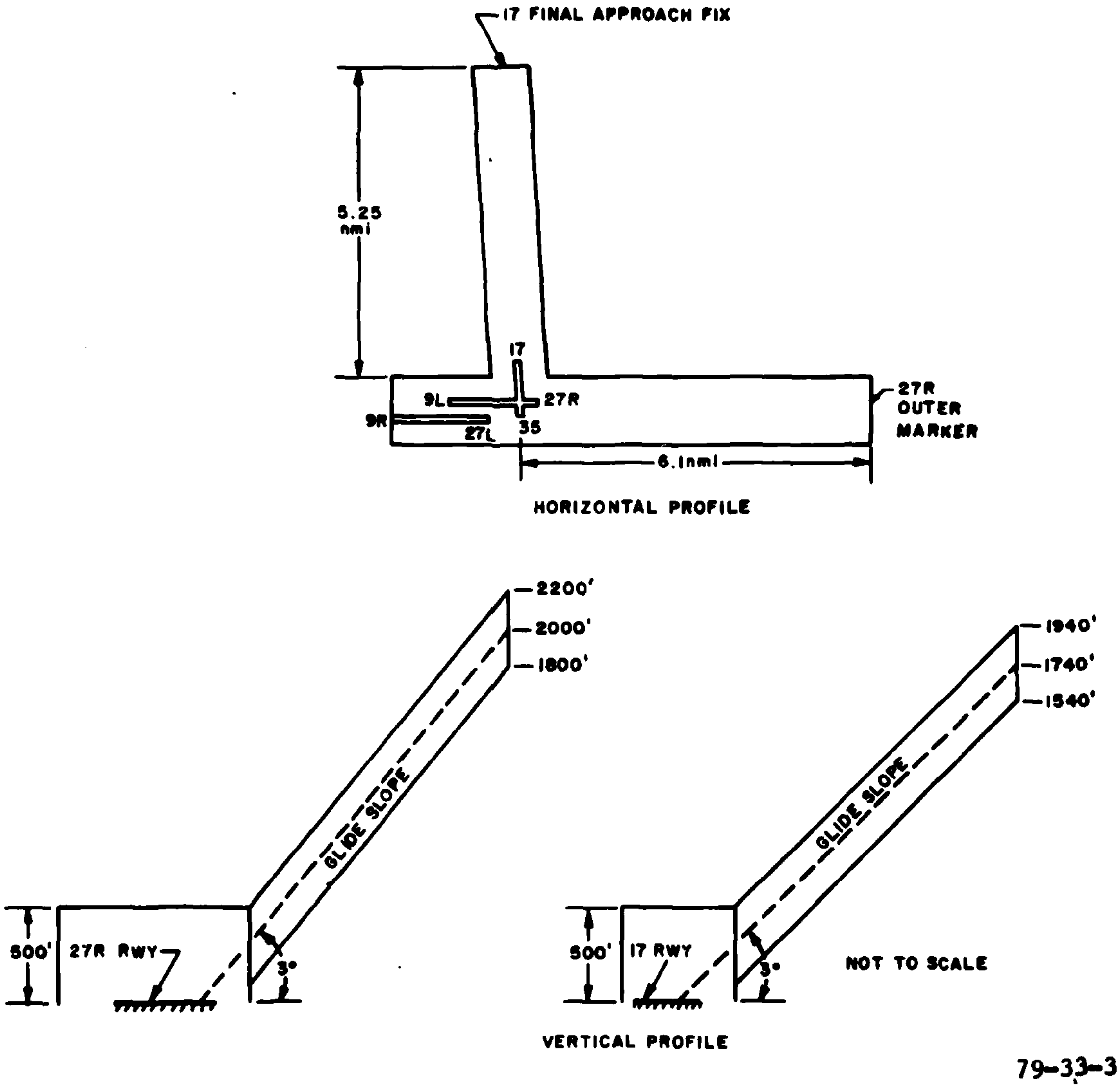

FIGURE 3. ATARS DESENSITIZED ZONE FOR THE VFR CONFIGURATION

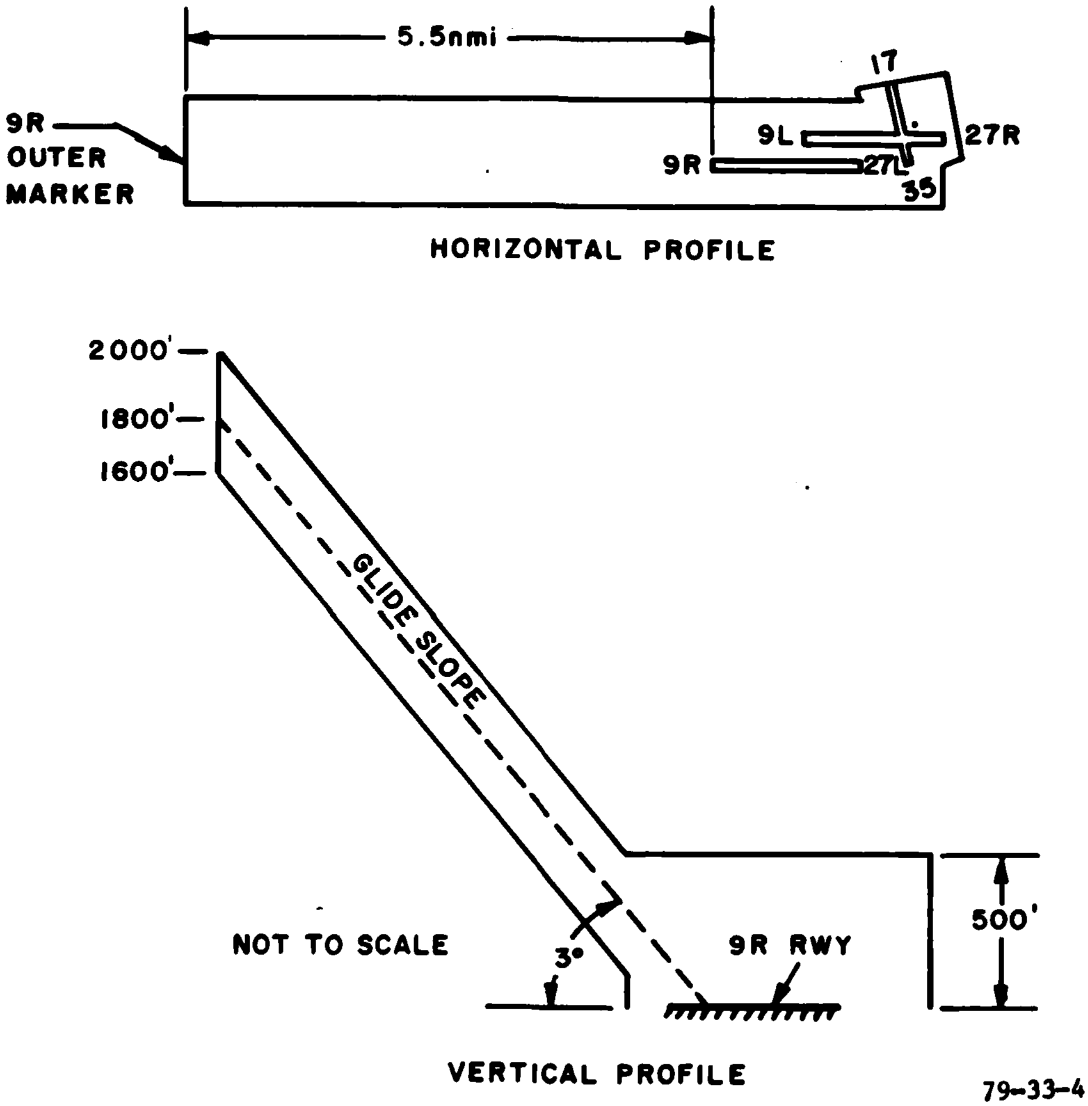

FIGURE 4. ATARS DESENSITIZED ZONE FOR THE IFR CONFIGURATION

resident in the ATARS logic, only one would be selected by the facility supervisor at any given time. This would prevent any unnecessary desensitization. Arrival aircraft established on the ILS course would not receive commands generated by aircraft on the ground or in the immediate vicinity of the airport. However, if an arrival aircraft should execute a missed approach, ATARS would be automatically reactivated to protect against departing or transient aircraft the moment the aircraft exited the approach sleeve.

SUMMARY OF RESULTS

GENERAL.

Automatic Traffic Advisory and Resolution Service (ATARS) interacts with pilots and controllers in the following ways;

1. When two aircraft are declared to be in potential conflict, ATARS issues (a) threat advisory Flashing Proximity Warning Indicator (FPWI) to the equipped aircraft, and (b) a controller alert to the Air Traffic Control (ATC) facility.

2. If the potential conflict persists and the command thresholds are met, ATARS issues (a) a resolution advisory (positive or negative command) to the equipped aircraft, and (b) a command notification to the ATC facility.

The events described in 1 and 2 above are generally described as ATARS alarms; however, the command alarm will clearly have a more serious impact on ATC operations.

In the discussion of results, it is important to separate the negative and positive aspects of ATARS/ATC interaction. Negative interaction occurs when ATARS issues threat and command alarms under circumstances in which the controller is using normal ATC procedures and operating within the guidelines of the ATC system. The effect of these undesirable alarms can be disruptive and the controller can become annoyed and casual to the ATARS. An effort will be made to identify the reasons for the alarms and suggest methods for eliminating or reducing them. ATARS positive interaction takes place when blunders in the system occur and ATARS provides a safe resolution service. How well ATARS handles the dynamics of the ATC system and how effective is the resolution attempted is the main thrust of these results.

OPERATIONS RATES.

The hourly operations rates achieved in each series, averaged over 4 hourly runs, are presented in table 1. Rates are broken out by arrivals versus departures at the main airport Philadelphia (PHL) and at the satellite airports collectively. A flight is counted in the operations rate if it either takes off or lands at any of the airports during the data hour. Overflights are counted separately from arrivals and departures. An overflight is a flight which neither originates nor terminates within the Terminal Radar Control

(TRACON) area. The maximum and average instantaneous aircraft counts (IAC) for the 4 hourly runs in each series are also listed.

TABLE 1. HOURLY OPERATIONS RATES AND INSTANTANEOUS AIRCRAFT COUNTS (IAC)

	PHL		SAT		OVER	TOTAL	IAC	
Series	ARV	DEP	ARV	DEP	FLIGHTS		MAX	AVG
PI	25.3	36.3	0	0	0	61.5	26.3	19.1
PIV	33.8	35.8	0	0	0	69.5	23.3	15.6
PSI	26.0	36.5	16.5	20.8	2	101.8	39.5	30.3
PSIV	35.0	34.0	20.0	21.0	9	119.0	43.0	29.1

There was very little variation in operations rates among the four runs within each series. There was only a 4 percent difference between the run with the lowest and highest operations rates.

ATARS ENCOUNTERS.

The ATARS encounters in each 4-hour series were analyzed to determine: the type aircraft involved, the arrival/departure status, the IFR/VFR flight status, the equipment capability (DABS/ATCRBS), and the number and duration of ATARS advisories. All aircraft were DABS/mode C equipped except in the NMC runs. In the NMC series, a percentage of the general aviation aircraft were ATCRBS/mode C and ATCRBS/mode A equipped.

Tabular data are presented which include all encounters where either a threat advisory (FPWI), a resolution advisory (command), and/or controller alert occurred. An analysis of proximity advisories (steady PWI's) is presented in a subsequent section of this report. Appendix B describes the four types of messages provided to aircraft by the ATARS.

PI SERIES.

The first test series was performed to investigate arrival/departure operations at the Philadelphia Airport under IFR operating procedures. A traffic density of 75 DABS/mode C equipped IFR aircraft per hour was simulated. No satellite traffic was present. This series produced only one ATARS encounter in 4 hours of testing, for an average of 0.25 encounters per hour. This result parallels the results obtained in previous simulations of a single airport IFR environment where no ATARS encounters occurred in 4 hours of testing (reference 2). Aircraft density for both studies was comparable. The single ATARS encounter was between an air carrier arrival and a general aviation arrival and produced only one scan of controller alert and two scans of threat advisories (FPWI's). The controller had cleared an aircraft to level off 1,000 feet below another aircraft in level flight. If the vertical tracker had been able to sense the level off sooner, the advisory would not have been uplinked. The aircraft had leveled off when the FPWI was displayed.

PIV SERIES.

This series investigated Philadelphia Airport traffic under mixed IFR/VFR operating conditions. The traffic density of 75 DABS/mode C equipped aircraft per hour was the same as used in the PI series. All air carrier aircraft were considered to be operating on IFR flight plans, and between these aircraft and other IFR aircraft, standard IFR separation was applied. One-half the air taxi and general aviation flights were considered to be IFR and the other half VFR. Within the TCA, 500-foot vertical separation was applied between IFR/VFR and VFR/VFR aircraft. Additionally, when aircraft were within 15 nmi of the radar antenna, horizontal separation could be reduced from 3 nmi to 1.5 nmi.

In this series, six ATARS encounters occurred in the 4 hours of testing which yields an average of 1.5 encounters per hour. Table 2 presents the details of the encounters. The duration of controller alerts (CA) is always one scan less than the total duration of an encounter involving an FPWI, since a two out of three rule was applied to the issuance of CA, whereas, no such rule applied to uplinked FPWI's. This rule required that CA thresholds be violated on two out of three consecutive 4-second scans before issuing a controller alert. No positive commands occurred and only one negative horizontal command of 4-second duration was generated for all encounters. The command encounter was between an arrival and a departure VFR general aviation aircraft. It occurred in the TCA approximately 5 miles from the airport. A plot of this TCA encounter is presented in appendix C (encounter 1). In five of the six encounters, at least one aircraft of each pair was VFR. Hence, VFR criteria was being applied.

TABLE 2. NUMBER AND DURATION OF ALARMS—PIV ALL AIRCRAFT DABS EQUIPPED—PHILADELPHIA AIRPORT ONLY

					No. of 4-Second Scans				
Run No.*	Enc No.	Aircraft User**	Flight Status**	Flight Rule**	Total	CA	FPWI	Neg. Adv.**	Pos. Adv.
1	1	AC/AT	D/A	I/V	5	4	5	0	0
	2***	GA/GA	A/D	V/V	3	2	2	1 NR	0
2	3	GA/GA	A/A	V/I	7	6	7	0	0
	4	GA/GA	A/A	I/V	3	2	3	0	0
3	5	AC/GA	D/A	I/I	4	3	4	0	0
	6	AC/GA	A/A	I/V	3	2	3	0	0
4	0	—	—	—	—	—	—	—	—

* For convenience, runs are tabulated 1 through 4; however, runs were conducted in random order over all 4 series.

** AC = AIR CARRIER, AT = AIR TAXI, GA = GENERAL AVIATION, D = DEPARTURE, A = ARRIVAL, I = IFR, V = VFR, NR = DON'T TURN RIGHT.

*** Example—encounter No. 2; total duration of 3 scans consisting of 2 scans of FPWI alone, plus 1 scan of negative right accompanied by FPWI. The controller was alerted (CA) for 2 of the 3 scans.

PSI SERIES.

In this series, aircraft operating to and from satellites around the Philadelphia TCA were added to the Philadelphia traffic. An additional 42 DABS/mode C equipped satellite operations and 2 DABS/mode C equipped overflights increased the basic 75 aircraft per hour density previously used to 119 aircraft per hour. Standard IFR separation cirteria were used as in the PI Series. The control of this environment proved to be particularly difficult for the test controllers. The need to combine control functions, due to a shortage of controller personnel and the general complexity of the area, were contributing factors.

Table 3 presents the PSI encounter data. There were nine ATARS encounters in the 4 hours of testing for an average of 2.25 per hour. Except for encounter 3, which is the only encounter involving an air carrier aircraft, all encounters involved at least one satellite aircraft. Five of the encounters involved at least one aircraft from Greater Wilmington (ILG) to the southwest and an additional three involved at least one from North Philadelphia (PNE) to the northeast. The crossing route structure generated by the satellite airport traffic caused the increased ATARS activity out beyond the TCA boundaries.

TABLE 3. NUMBER AND DURATION OF ALARMS--PSI ALL AIRCRAFT DABS EQUIPPED--IFR ONLY

					No. of 4-Second Scans				
Run No.*	Enc No.	Aircraft User**	Flight Status**	Test Airport	Total	CA	FPWI	Neg. Adv.**	Pos. Adv.**
1	1	GA/AT	D/D	PHL/ILG	8	7	5	3 NL	0
	2	GA/GA	A/O	ILG/OVR	9	8	3	0	6 C/D
2	3	AC/AT	A/A	PHL/PHL	4	3	4	0	0
	4	GA/GA	A/D	ILG/ILG	9	8	8	1 NL	0
	5	GA/AT	A/A	ILG/PHL	3	2	3	0	0
3	6	GA/AT	D/A	PNE/TTN	5	4	5	0	0
	7	GA/MI	D/A	PNE/NXX	11	10	5	4 NR	2 L
4	8	AT/AT	D/A	PNE/TTN	2	1	2	0	0
	9	GA/GA	D/A	ILG/ILG	5	4	5	0	0

* For convenience, runs are tabulated 1 through 4; however, runs were conducted in random order over all 4 series.

**AC = AIR CARRIER, AT = AIR TAXI, GA = GENERAL AVIATION, MI = MILITARY, D = DEPARTURE, A = ARRIVAL, PHL = PHILADELPHIA, ILG = GREATER WILMINGTON, O = OVR = OVERFLIGHT, PNE = NORTH PHILADELPHIA, NXX = NAVY WILLOW GROVE, TTN = TRENTON, NL = DON'T TURN LEFT, NR = DON'T TURN RIGHT, C/D = CLIMB/DESCEND, L = TURN LEFT.

Two of the nine encounters resulted in negative horizontal commands of short duration and two resulted in positive commands. With the exception of a Philadelphia departure, all other commands were issued to satellite airport traffic. All command encounters occurred outside the TCA. Plots of the four command encounters along with a detailed description of the encounter are presented in appendix C. The major result of the PSI series is the complete lack of any ATARS activity within the Philadelphia TCA and the very low positive command rate of 0.5 per hour over the 4 hours of runs.

PSIV SERIES.

In this series, approximately 50 percent of the population operated under VFR conditions in a mixed IFR/VFR environment. Sample density was the same as series PSI except that 7 VFR DABS/mode C equipped overflights are added.

In the four runs of the PSIV series, the eight encounters shown in table 4 were recorded. All aircraft in these encounters were flying under VFR separation criteria. Four of the encounters resulted in threat advisories only, two resulted in positive vertical commands, and two resulted in negative horizontal commands of only one scan duration. All encounters occurred outside the TCA. Plots of all the command encounters are contained in appendix C. Here again, the major results of the PSIV series are comparable to the PSI series to the extent of no ATARS activity within the TCA, the almost exclusive involvement of satellite traffic in all encounters, and the identical low positive command rate of 0.5 encounters per hour over the 4 hours of runs.

TABLE 4. NUMBER AND DURATION OF ALARMS--PSIV ALL AIRCRAFT DABS EQUIPPED

Run No.*	Enc No.	Aircraft User**	Flight Status**	Flight Rule**	Test Airport	No. of 4-Second Scans: Total	CA	FPWI	Neg. Adv**.	Pos. Adv**.
1	1	GA/AT	O/A	V/V	OVR/PNE	7	6	6	1 NR	0
	2	GA/GA	A/D	V/V	ILG/ILG	9	8	5	0	4 C/D
	3	AC/GA	A/A	I/V	PHL/PHL	3	2	3	0	0
2	—	NONE	—	—		—	—	—	—	—
3	4	AC/GA	A/A	I/V	PHL/ILG	2	1	2	0	0
	5	GA/GA	A/O	V/V	PHL/OWR	9	8	5	0	4 C/D
4	6	AT/GA	D/O	V/V	PHL/OVR	2	1	2	0	0
	7	AC/GA	A/A	I/V	PHL/ILG	6	5	5	1 NR	0
	8	AT/GA	D/D	V/V	ILG/ILG	2	1	2	0	0

* For convenience, runs are tabulated 1 through 4; however, runs were conducted in random order over all 4 series.

** AC = AIR CARRIER, AT = AIR TAXI, GA= GENERAL AVIATION, D = DEPARTURE, A = ARRIVAL, O = OVR = OVERFLIGHT, I = IFR, V = VFR, NR = DON'T TURN RIGHT, C/D CLIMB/DESCEND.

LOCATION OF ENCOUNTERS.

In 16 hours of simulation, a total of nine command encounters occurred. Five of these resulted in negative horizontal advisories, three in positive vertical advisories, and one in positive horizontal advisories. The locations of the encounters are shown in figure 5 for the IFR environment, and figure 6 for the IFR/VFR environment. The 20-nmi circle about the primary airport represents the outer radius of the TCA boundary. (See figure 9 for greater detail.) The numbers on the charts represent the encounter numbers found in appendix C. All encounters occurred at or below 7,000 feet mean sea level (m.s.l.) and eight of the nine encounters were vertically or horizontally outside the TCA. The one encounter within the TCA was between a Philadelphia departure and an arrival to the VFR runway 17 at Philadelphia. VFR altitude separation was being applied, and at the time of the negative horizontal advisory, horizontal track divergence was in progress. In eight of the encounters, at least one aircraft of each pair was associated with a satellite airport.

ATARS/CONTROLLER INTERACTION.

The extremely low positive command rate of four aircraft pairs in 16 hours of data collection produced very little interaction with the controller. Negative commands were displayed to the controllers; however, none of these commands affected aircraft flightpaths and so did not interact with the controller. It was observed that controllers did not alter normal spacing or control procedures, operations rates were high, and no missed approaches resulted because of ATARS alarms. The controllers indicated that ATARS messages displayed as blinking characters in the third line of the ARTS III data block were sufficient information for the controller for the few times that they occurred.

AIRCRAFT SEPARATION ANALYSIS.

Figure 7 is a scan-by-scan plot of those encounters (Nos. 1, 2, 4, 6, 9) that resulted in negative resolution advisories. In those encounters (Nos. 1, 2, 4) that actually enter the 500 foot by 1.5 nmi area, the controller is applying separation based on the observed divergence of aircraft tracks. More detailed plots are contained in appendix C.

Figure 8 shows the separation between aircraft pairs that existed during each scan of the four ATARS encounters which resulted in the issuance of positive commands. The type of message; i.e., controller alert, threat advisory (FPWI), or resolution advisory that existed on each scan is also shown. Controller alert and FPWI time thresholds were the same; however, controller alerts were displayed only after thresholds were violated in two out of three consecutive scans. No such rule applied to FPWI; therefore, on the first scan of an encounter, an FPWI was uplinked to the aircraft, but a controller alert was not displayed. In encounters 5, 7, and 8, it is to be noted that although the aircraft are closing horizontally, they are diverging vertically. In these three encounters, the controller had issued instructions to vertically separate the aircraft prior to the ATARS algorithm generating any positive commands. Thus, in these encounters, the controllers essentially resolved the conflicts, although the ATARS controller alert may have attracted the attention of the

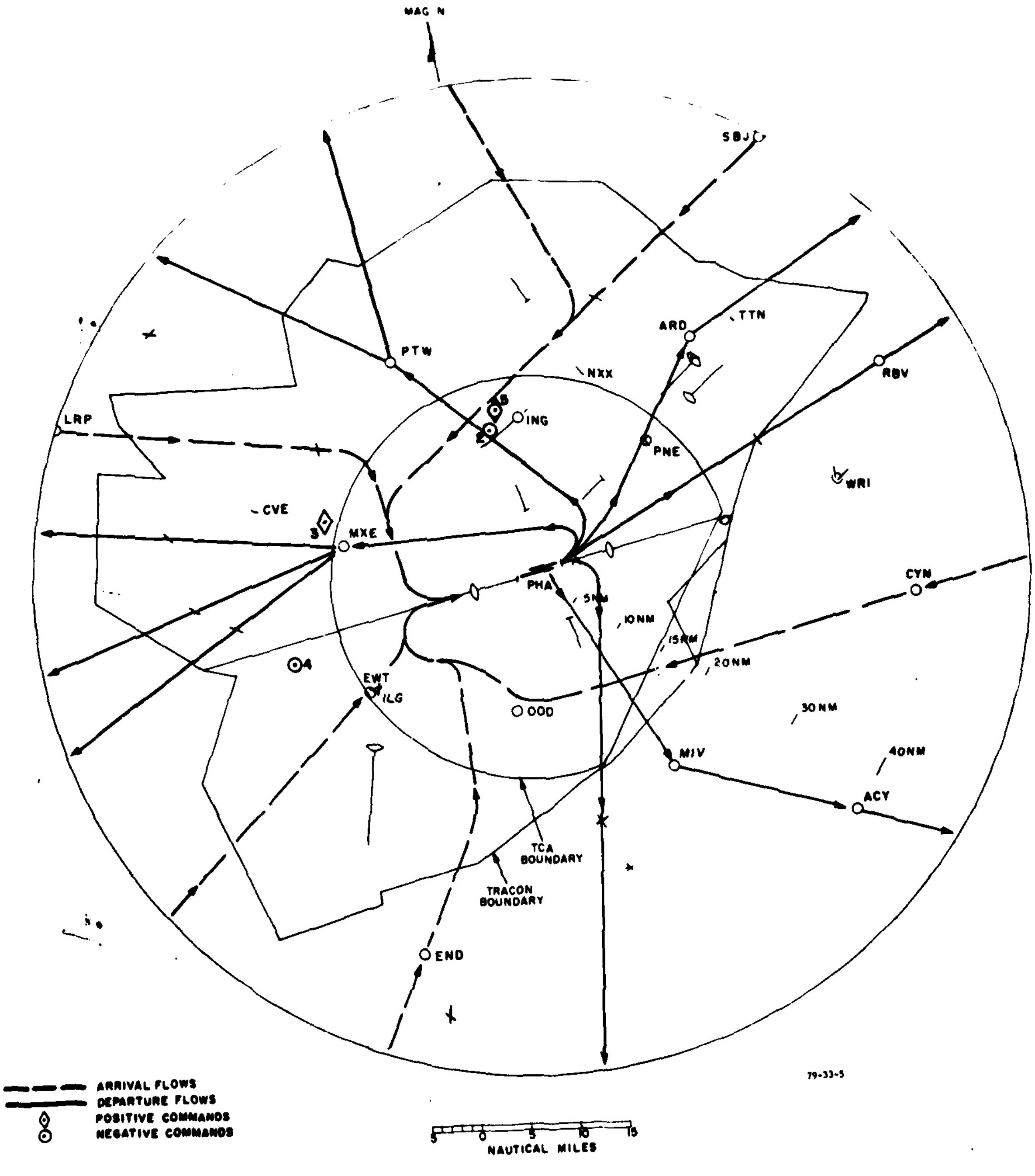

FIGURE 5. IFR ENVIRONMENT ATARS COMMAND ENCOUNTERS

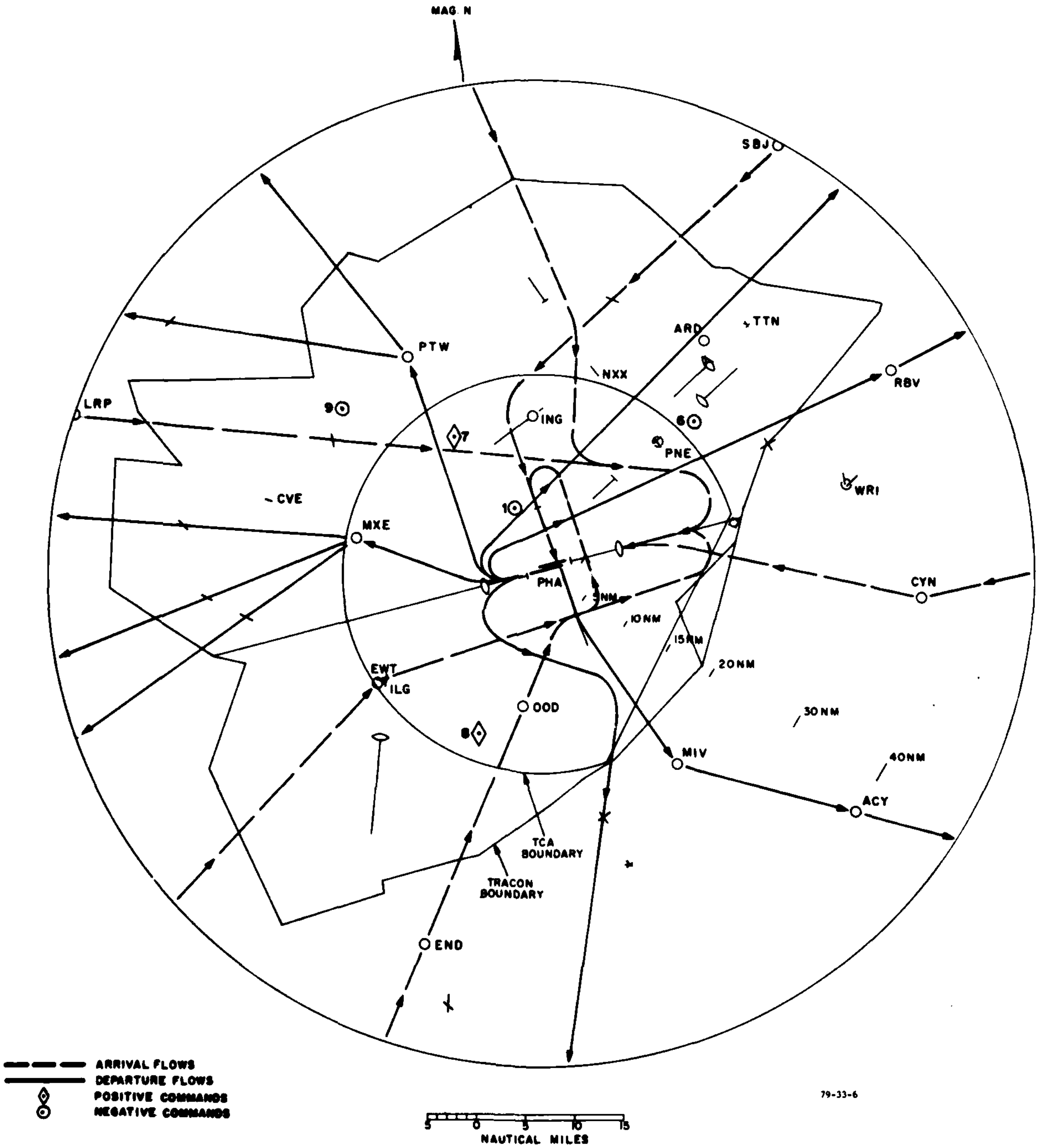

FIGURE 6. IFR/VFR ENVIRONMENT ATARS COMMAND ENCOUNTERS

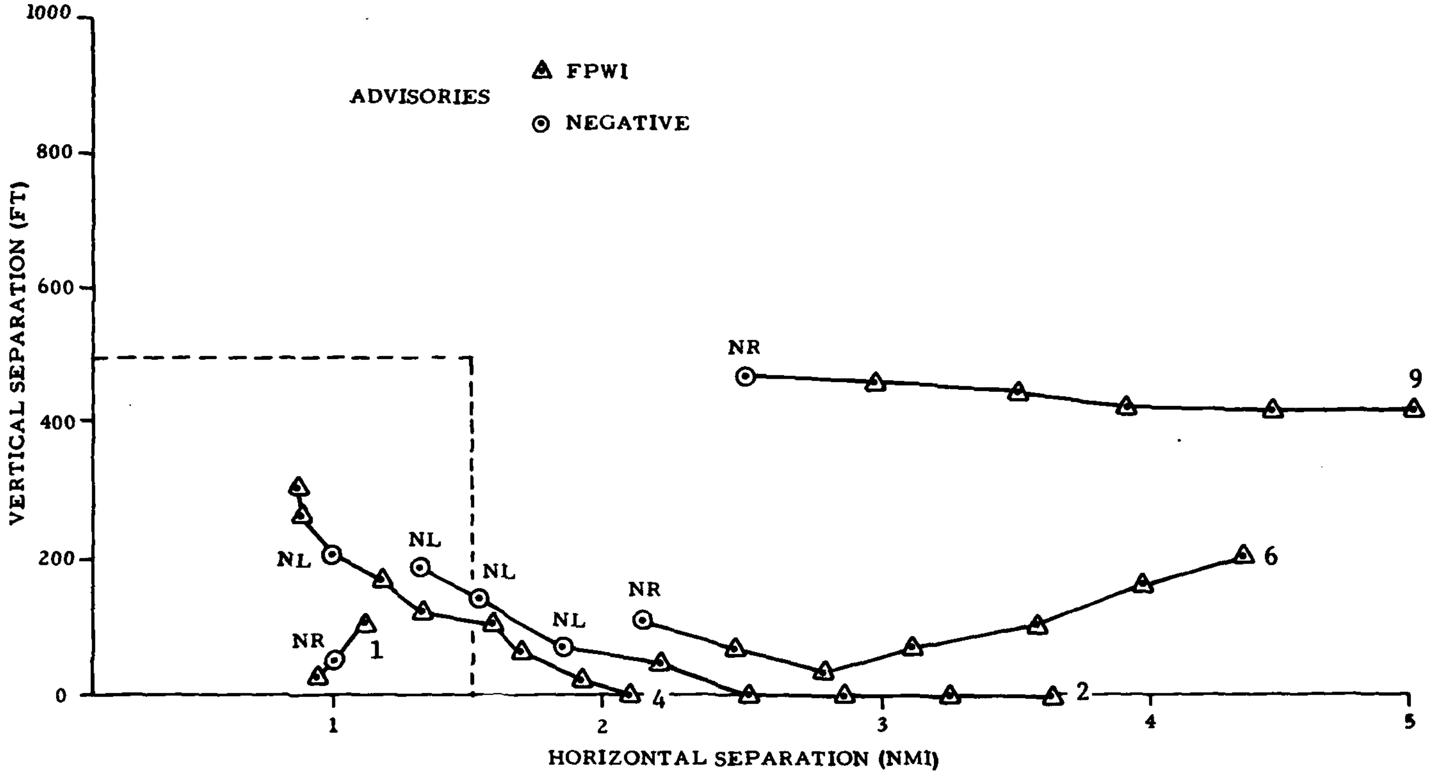

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FIGURE 7. AIRCRAFT SEPARATION--NEGATIVE ADVISORIES

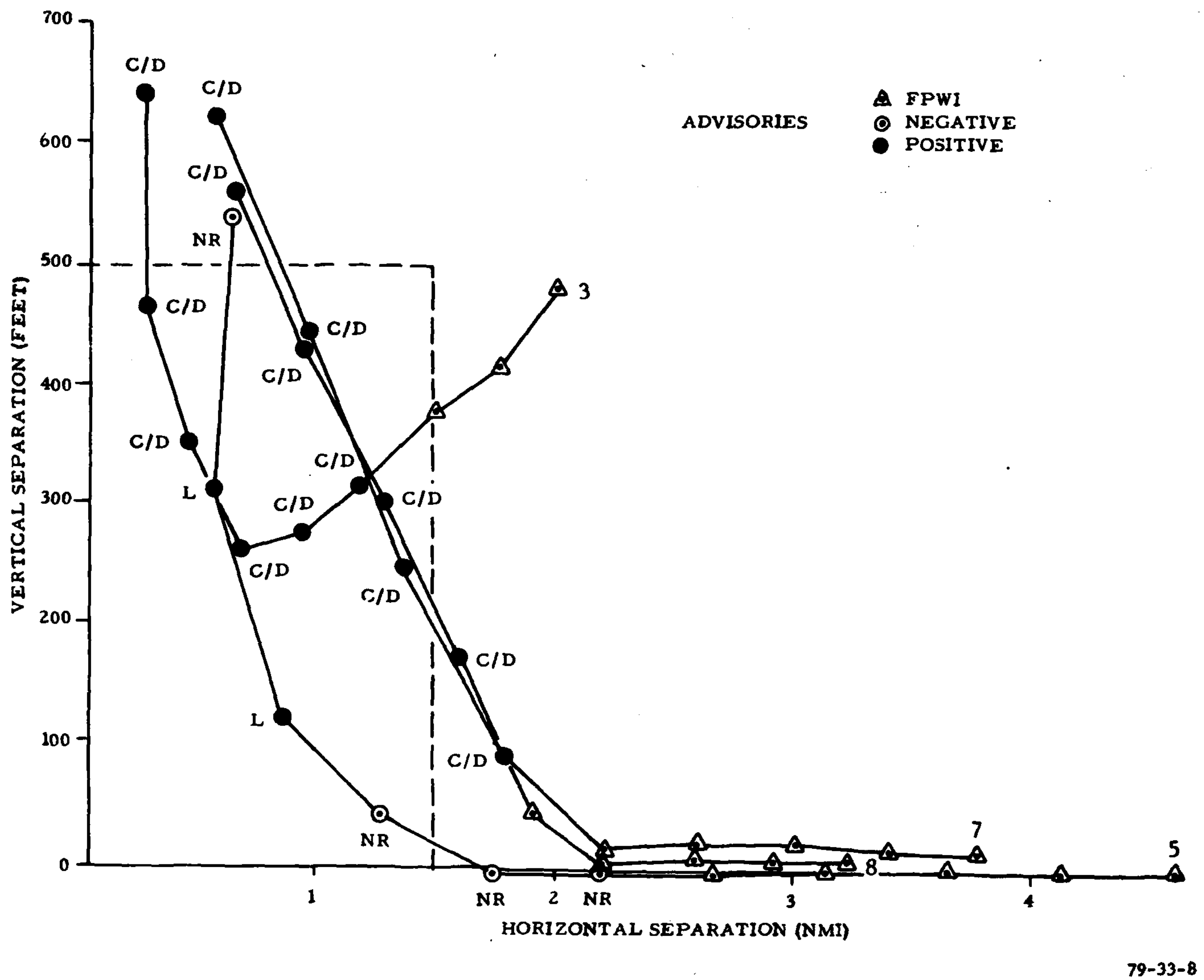


FIGURE 8. AIRCRAFT SEPARATION--POSITIVE ADVISORIES

controllers. Encounter 3 was clearly the result of a controller blunder and it was ATARS that saved the day. Both the horizontal and vertical separations decreased until the aircraft responded to the ATARS issued commands. At point of closest approach, the aircraft were separated by 0.3 nmi horizontally and 642 feet vertically.

ATARS DESENSITIZATION ANALYSIS.

In the previous NAFEC ATCSF/ATARS simulation tests in a Chicago-type environment (reference 2), ATARS desensitization zones were considerably different from those used in the Philadelphia tests. One of the objectives of the present study was to provide insight as to the location, size, and shape of the desensitization zones required to site adapt ATARS to the Philadelphia TCA environment. A second point of interest was whether any of the runways at the numerous satellite airports should be desensitized.

All the encounters recorded during these simulation runs occurred either in the vicinity of the satellite airports or at the major crossover points for the Philadelphia arrival and departure aircraft. Very few of the conflicts occurred right at the satellite airports, but rather occurred at those crossover points where Philadelphia traffic patterns intersected the satellite airports traffic patterns. Insufficient encounters were recorded at any given airport to justify desensitization. This may, however, be due to the total density simulated at the satellite airports. Although ATARS was desensitized for aircraft on the ILS approach course at Philadelphia, provisions were made to collect ATARS encounter data in the desensitized final approach zones (FAZ), even though alarms were not uplinked to aircraft inside the zone. This was done for two purposes: (1) to assess the effectiveness of the desensitization zone in eliminating undesirable ATARS alarms between aircraft on converging ILS approach courses, between aircraft on final and surface traffic, and between arrival and departure aircraft; and (2) to gather data that could be used to determine if the desensitization zone could be further reduced in size, thus, providing a higher level of protection closer to the airport. Table 5 shows the total number of encounters that occurred in each series, the number that occurred in the FAZ (not uplinked to aircraft), and the percent in the FAZ.

The percent of encounters in the desensitization zone ranged from a low of 81.6 percent recorded in the PSI series to a high of 96.8 percent recorded in the PSIV series. It is to be recalled that, although FPWI's and commands are generated for aircraft in the desensitized zones, only steady PWI's were uplinked.

TABLE 5. ATARS ENCOUNTERS

Series	Enc Total	* Enc FAZ	Percent FAZ
PI	31	30	96.8
PIV	122	116	95.1
PSI	49	40	81.6
PSIV	104	96	92.3

*Encounters in which at least one of the aircraft was located within the FAZ.

After a preliminary analysis of the number of alarms in the FAZ was completed, additional study was undertaken to determine if even further reduction of the FAZ could be achieved. For this purpose, only the PSI and PSIV series were investigated. These two series were felt to be the most realistic and representative of TCA operations. An analysis was made of the distance from the runway threshold when the first FPWI would have been uplinked to an arrival aircraft in an ATARS encounter, had it not been inhibited by the desensitization logic. For departure aircraft, a determination was made of the distance from the runway threshold when the last FPWI would have been uplinked had it not been inhibited.

Tables 6 and 7 show the number of aircraft that would have received FPWI's at the indicated distances from runway threshold had the desensitization not been in effect. As can be seen in table 6, in the PSI series, all conflicts occurred within 1.0 nmi of the runway thresholds. In table 7, in the PSIV series, 98 percent of the arrivals and all of the departure ATARS encounters occurred within 1.5 nmi of the runway threshold. The remaining 2 percent occurred 1.5 to 2 nmi from runway threshold. Based on this analysis, the Philadelphia ATARS desensitization zone used in this study, which extended to the outer marker, can be further reduced to less than half the distance (about 2 nmi) from the runway to the outer marker.

CONVERGENCE/DIVERGENCE LOGIC.

In the algorithm used in the 1975/1976 ATCSF/ATARS tests, special checks were made on a conflict pair to test the relative times of horizontal and vertical convergence. The special logic looked at both the horizontal and vertical dimensions simultaneously, and inhibited generation of controller alert, FPWI's and commands when the aircraft were projected to be converging in one dimension, but diverging in the other. Basically, the relative positions of the aircraft pair in both dimensions were projected to determine if conflict thresholds were simultaneously violated. See reference 3 for a more detailed explanation of this logic. This special logic was not used in the current tests. Had the algorithm contained the convergence/divergence logic, two of the command encounters that occurred in the PSI series, and two in the PSIV series would have been reduced in duration by one or two scans. None of the command encounters would have been completely eliminated. In fact, all four of the aforementioned command encounters would have had two scans of commands generated, even with the special logic. Some form of convergence/divergence logic should, however, be incorporated into all future versions of the ATARS algorithm.

VERTICAL TRACKER LAG.

Vertical tracker lag continues to impact the performance of the ATARS algorithm in that it is responsible for either triggering an alarm unnecessarily or continuing it unnecessarily. This is particularly true under VFR separation procedures when aircraft are leveling off 500 feet below or above an aircraft in level flight. The tracker overshoots the level off and triggers an alarm. An analysis of the track plots of all encounters indicated that in seven encounters, tracker lag was involved in either triggering an advisory unnecessarily or extending its duration. The tracker lag did not have a significant impact in the nine command encounters.

TABLE 6. NUMBER OF AIRCRAFT AND DISTANCE FROM RUNWAY WHEN FIRST FPWI UPLINKED—PSI SERIES

DISTANCE FROM RUNWAY THRESHOLD	RUNWAY ARR 9R	DEP 9L	DEP 17	TOTAL NO. OF AIRCRAFT
ON RUNWAY	16*	33*	9	58
0.0 - 0.5 nmi	13	0	3	16
0.5 - 1.0 nmi	5	0	0	5
TOTAL	34	33	12	79

TABLE 7. NUMBER OF AIRCRAFT AND DISTANCE FROM RUNWAY WHEN FIRST FPWI UPLINKED—PSIV SERIES

DISTANCE FROM RUNWAY THRESHOLD	RUNWAY ARR 27R	ARR 17	DEP 27L	DEP 17	TOTAL
ON RUNWAY	24*	7	25*	17	73
0.0 - 0.5 nmi	5	10	0	5	20
0.5 - 1.0 nmi	11	17	0	0	28
1.0 - 1.5 nmi	32	8	0	0	40
1.5 - 2.0 nmi	1	1	0	0	2
TOTAL	73	43	25	22	163

* Includes one scan duration uplinks on runway

UNCONTROLLED SERIES SPECIAL TESTS.

At the conclusion of formal data collection, several test runs were conducted which introduced a quantity of uncontrolled aircraft into the simulated environment. VFR flight plans were obtained from the North Philadelphia Flight Service Station (FSS) and were studied to determine flight tracks for uncontrolled aircraft. The data proved to be inadequate since the intended courses in the immediate vicinity of the Philadelphia area were not indicated. Information was not provided on whether the pilot would remain uncontrolled or would contact Philadelphia approach control and become a controlled flight. In order to develop and verify a traffic model of uncontrolled aircraft in the Philadelphia terminal area, a more extensive and time consuming data collection and analysis would have been required. For this study, it sufficed to develop a realistic uncontrolled traffic sample which could be used to highlight problem areas. The intent was not to gather alarm rate data, hence, no quantitative results are presented.

For simulation purposes, it was postulated that a pilot desiring to transit the geographical airspace outside the TCA from "A to B" without communicating with the control facility would only deviate from the intended track sufficiently to avoid the physical boundaries of the TCA. Depending upon the altitude of the flights, which in most cases are low performance aircraft, this tends to constrict the uncontrolled aircraft to areas below the floors of the TCA or in a narrowband outside the TCA (figure 9). Even though this is normal procedure for uncontrolled aircraft today, it is conceivable that TCA's might not exist when all aircraft have collision avoidance systems (CAS). Moreover, even in a TCA terminal environment, pilots of equipped aircraft might be less concerned about skirting a TCA with the electronic protection of ATARS.

The results of the uncontrolled test series indicated that in some cases, where conflict resolution between uncontrolled aircraft flying below the TCA involved vertical commands, aircraft were maneuvered into the supposed inviolate TCA.

Two solutions to this problem, if indeed it is a problem in light of complete ATARS protection, would be:

1. Include the TCA dimensions in the ATARS adaptation data similar to the way a restricted area would be handled to prevent a violation of such airspace.

2. Define buffer zones near a TCA to exclude uncontrolled aircraft operations. Most resolutions can be achieved within a 1-nmi horizontal or 500-foot vertical deviation. Therefore, advising or ruling that aircraft maintain these distances (a simple feat with area navigation (RNAV)) from the TCA should eliminate inadvertent entry.

From the standpoint of the controller, the major problem which was caused by the uncontrolled aircraft was the clutter produced on the display as a result of ATARS displayed data. When a controlled aircraft is in an encounter with an uncontrolled aircraft, the complete data block of the uncontrolled aircraft is forced onto the display. These data, in conjunction with the flashing

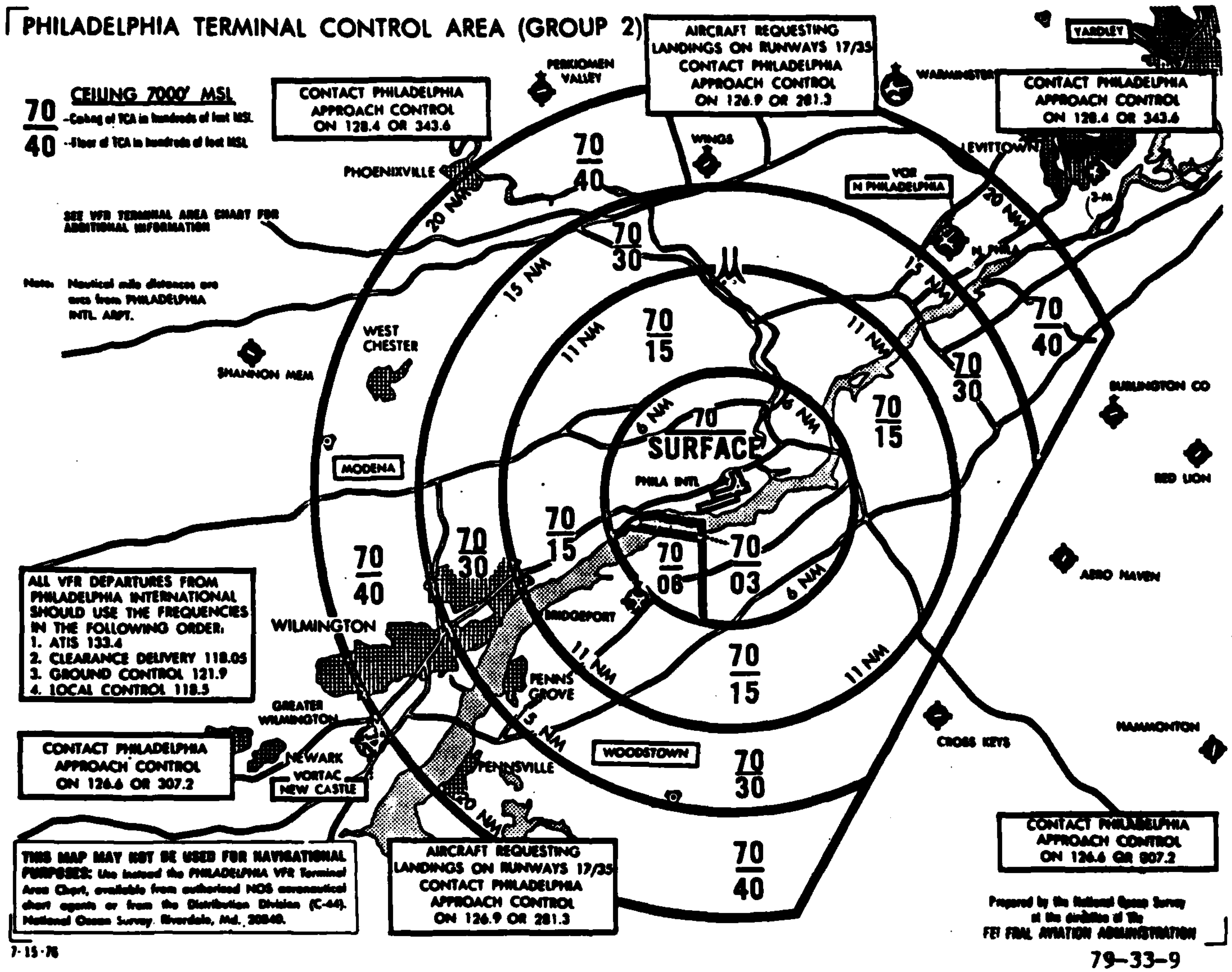


FIGURE 9. PHILADELPHIA TERMINAL CONTROL AREA (TCA)

vector line, tends to aggravate an already complex traffic picture. In addition, the controller, not being in communication with the uncontrolled aircraft, has no knowledge of what that aircraft might do. It might maneuver immediately to relieve the situation or it might not maneuver until the controller had initiated some instruction to the controlled aircraft and then possibly maneuver so as to negate the controller's instruction. It should be mentioned that, in these particular tests, the uniform logic concept replaced the former logic that would have caused the uncontrolled aircraft to receive an ATARS command prior to a controlled aircraft. The use of the original logic would undoubtedly have eliminated many of the controller alerts experienced in these tests.

The tests indicated that a horizontal and vertical buffer is necessary to preclude a high number of undesirable alarms between controlled aircraft operating within the TCA and uncontrolled aircraft flying in proximity to the horizontal and vertical boundaries of the TCA. Also, uncontrolled aircraft operating around TCA's and in high density terminal areas such as satellite airport environments, should receive advisories and advisory resolution prior to controlled aircraft in order that the organization of controlled aircraft not be disturbed.

NMC SPECIAL TESTS.

The primary purpose of the non-mode C runs was to highlight problems that might exist with non mode C-equipped aircraft flying in proximity to DABS-equipped aircraft which might be maneuvering in response to ATARS commands. There was concern that an aircraft responding to an ATARS command would be maneuvered into a conflict with a non-mode C aircraft for which no ATARS protection exists. Within the basic VFR traffic sample of 126 aircraft, 36 general aviation type aircraft were considered to be only mode A (non-mode C) equipped, 12 were considered to be ATCRBS mode C equipped and the remainder or 78 aircraft were DABS mode C equipped. In analyzing the individual encounters, there was no evidence to show that ATARS lack of knowledge of ATCRBS mode A aircraft introduced any hazardous situations. This is a reasonble expectation in a controlled environment with a managed traffic flow. In a more random uncontrolled environment, unequipped aircraft may pose a more serious threat to equipped aircraft being maneuvered by ATARS.

PROXIMITY ADVISORIES (PWI) ANALYSIS.

DISCUSSION. Proximity advisories are involved in all uplinks sent to aircraft to include steady PWI's, flashing PWI's, and commands all of which provide relative altitude and relative bearing of the intruder aircraft.

The proximity advisory data was analyzed to determine: how often a typical aircraft experienced traffic advisories, how long the advisories lasted, how many were received at one time, and the geometry of the encounter; e.g., head-on or tail chase. Only the data for PSI and PSIV are included, since these series most resemble the Philadelphia IFR and mixed IFR/VFR TCA controlled aircraft environments, respectively. Uncontrolled aircraft were not included in these tests. Undoubtedly, proximity advisory rates would have been higher,

had a valid uncontrolled traffic scenario existed and been included in the traffic scenarios. These data are an initial estimate of proximity advisory activity in a fully equipped DABS/ATARS environment and reflect what the distribution might be in a controlled TCA environment.

ATARS INDIVIDUAL AIRCRAFT EFFECT.

There was an average of 101 ordinary PWI (OPWI) encounters per hour in the PSI series and 144 encounters per hour in the PSIV series in which at least one PWI advisory was issued to both aircraft. As can be seen from table 8, a typical aircraft under IFR operations was involved in about 1.7 encounters per hour, and under mixed IFR/VFR operations in 2.4 encounters per hour. The closer proximity of aircraft under VFR operations results in increased OPWI activity. Advisories lasted approximately 48 seconds for both the PSI and PSIV encounters.

TABLE 8. PWI ENCOUNTER SUMMARY

Series	Average Number of Active Aircraft Per Hour	Average Number of OPWI Paired Encounters Per Hour	Average Number of Encounters Per Aircraft	Average Encounters Duration (Seconds)
PSI	115.8	100.8	1.7	47.2
PSIV	120.0	143.5	2.4	49.2

In order to characterize the level of OPWI activity a pilot might experience in the cockpit, the data were broken down into the number and duration of lights lit on the IPC (BADCOM) display. The BADCOM, figure 10, is a candidate cockpit display which displays PWI advisories and negative and positive commands to a pilot. The 12 sets of three lights on the outer ring of the display are used to indicate the relative bearing (at 30° intervals) and relative altitude, above, below, or coaltitude (+,-500 feet) of an intruder aircraft. A red X instructs the pilot not to maneuver in that direction and a green arrow directs the pilot to execute a maneuver in the direction and dimension specified.

Table 9 presents data on the number of proximity advisory lights lit on the display at any one time and the average duration of these lights. The table lists the number of aircraft that had exactly n lights lit simultaneously, where n=1, 2, 3, 4. A single aircraft in which one light was lit for five scans, two lights lit simultaneously for an additional five scans, and three lights lit simultaneously for an extra six scans, would have a 1 added to each of the totals for n=1, 2, and 3 lights lit. The numbers represent averages over the four runs of each series. Thus, in the PSIV runs, there was an hourly average of 35 aircraft in which the pilot had two lights on his BADCOM display lit simultaneously for an average duration of 36 seconds (nine scans). The maximum number of multiple lights lit simultaneously on a single aircraft was four. This happened to only one aircraft and lasted for three scans.

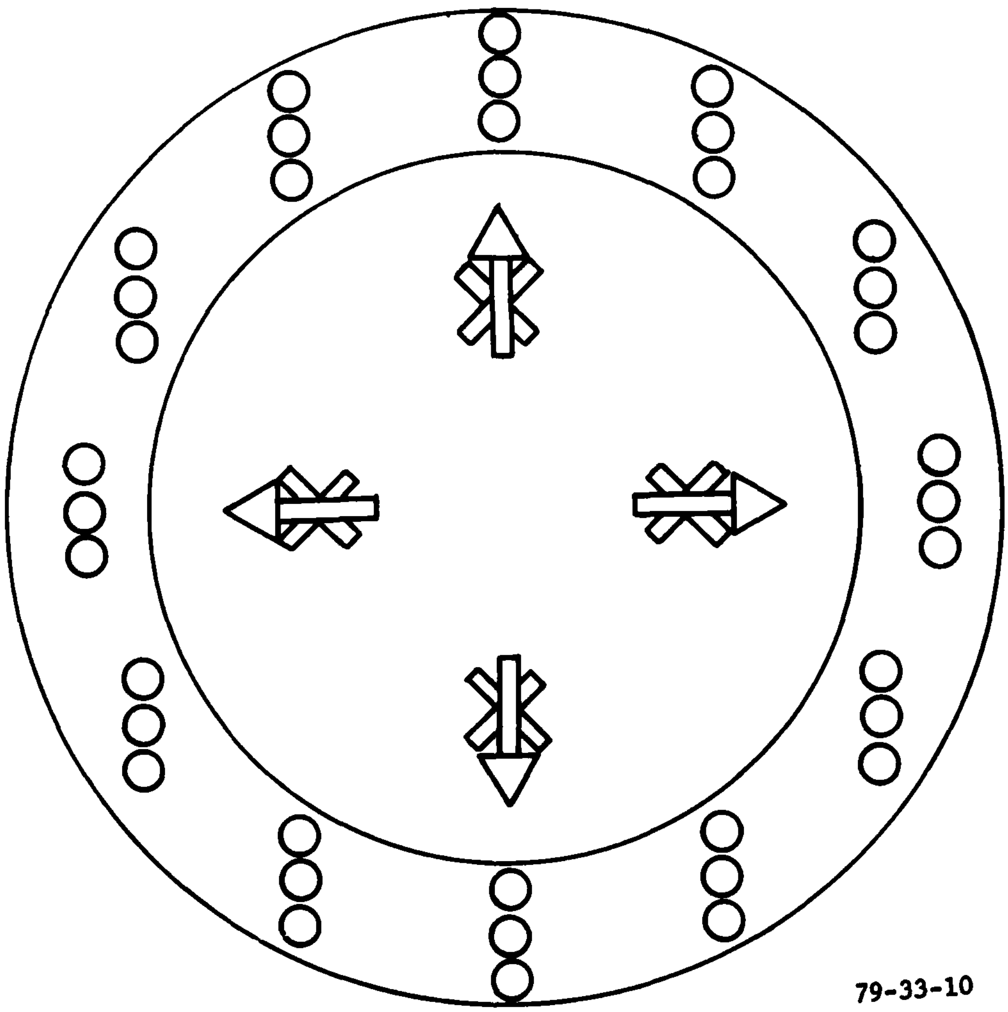


FIGURE 10. BADCOM DISPLAY

TABLE 9. AIRCRAFT PROXIMITY ADVISORIES HOURLY RATE (PILOT DISPLAY VIEWPOINT)

Series	Number of Active Aircraft	Average Flight Duration Minutes and Seconds	Simultaneous Proximity Advisories No. of Aircraft (No. of 4-Sec. Scans) 1	2	3	4
PSI	115.8	14.54	84.8(27)*	19.5(9)	0.5(3)	—
PSIV	120.0	13.47	102.4(28)	35 (9)	6 (4)	0.3(3)

*Numbers in parenthesis represent average duration in 4-sec. scans.

Over many flights in the environment, an aircraft would on the average have one or more OPWI's displayed 9.8 percent of its flight time in the PSI series and 13.2 percent in the PSIV series. In only a small percentage of flight time, 0.7 percent for PSI and 1.4 percent for PSIV, were 2 or more lights simultaneously lit.

An analysis was made of the relative position of aircraft at the start of an encounter to determine whether the aircraft were diverging in a tail-chase or flying head-on. These situations were defined by the relative bearing of each aircraft from one to another during an encounter. If paired aircraft viewed each other at the 8 o'clock through 4 o'clock relative bearing, this was considered a head-on encounter. If the lead aircraft showed the intruder to be in the 5 o'clock through 7 o'clock bearing and the following aircraft displayed the lead aircraft at the 8 o'clock through 4 o'clock bearing, the encounter was a tail-chase. A diverging encounter existed when both aircraft were in the 5 o'clock through 7 o'clock bearing relative to each other. Figure 11 defines the three encounter situations by clock positions of the bearing of each aircraft relative one to another. Table 10 shows the percentage of total encounters that were head-on, tail-chase, or diverging. In less than 1 percent of the encounters were the aircraft diverging, a significant portion, roughly 71 percent, were encounters in which the intruder was within a bearing from 8 o'clock to 4 o'clock relative to its own aircraft. The remaining encounters, approximately 28 percent, were tail-chase situations. It can also be seen that the average horizontal separation between aircraft at the start of an encounter was 2.5 nmi over all encounters.

TABLE 10. GEOMETRY AT START OF ENCOUNTER

Series	Percent Head-On	Percent Tail Chase	Percent Diverging	Average Range Between Aircraft (nmi)
PSI	66.5	33.5	0.0	2.5
PSIV	75.8	23.3	0.9	2.5

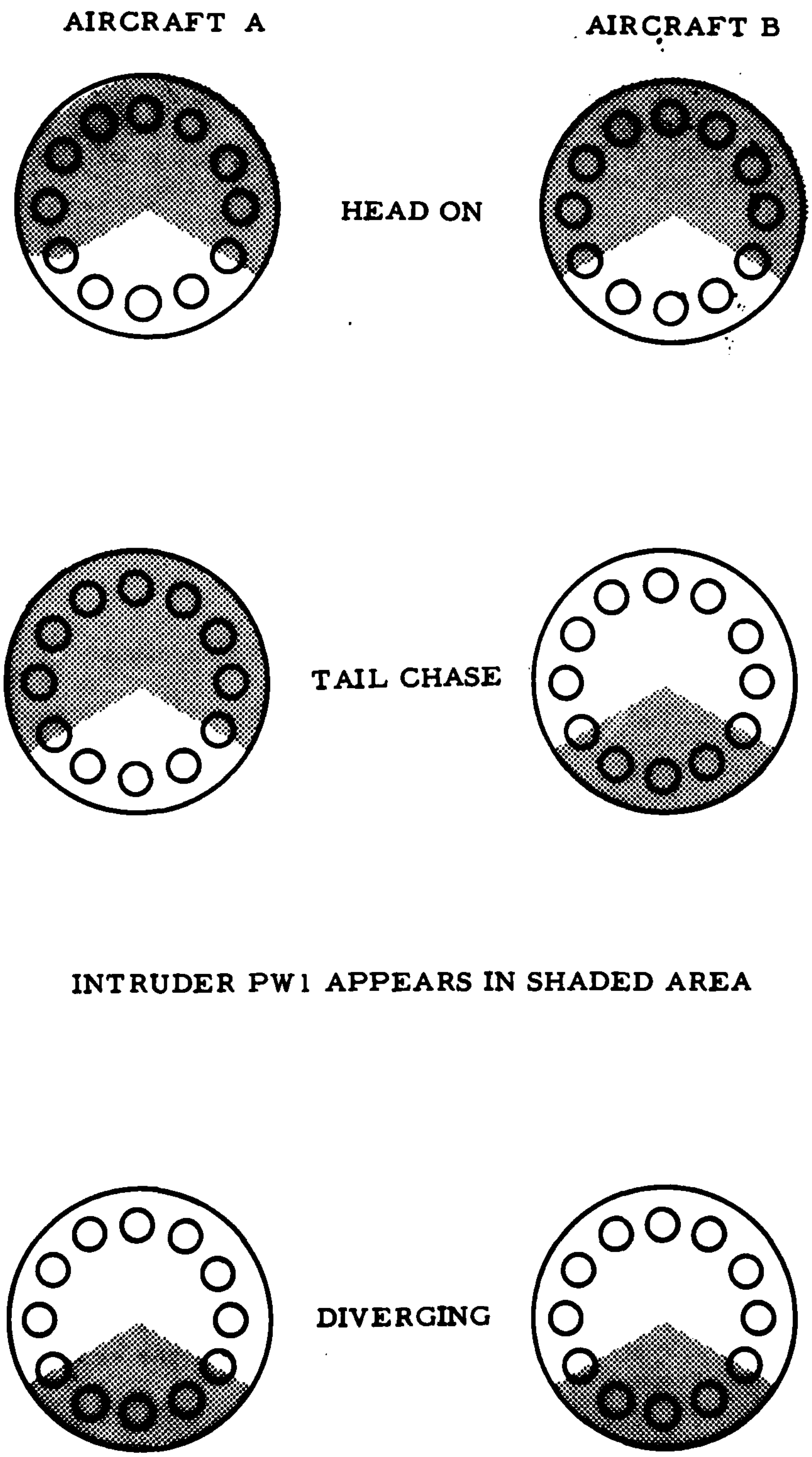


FIGURE 11. DEFINITION OF HEAD-ON, TAIL-CHASE AND DIVERGING ENCOUNTER (PWI CLOCK POSITION)

Table 11 lists the percent of a data hour in which 0, 1, 2, ---, 10, aircraft were uplinked at least one advisory within the same second. The maximum number of aircraft sent an uplink during any 1 second was 10. As can be seen, there were no aircraft sent (X = 0 column) an uplink 60 percent of the time in the PSIV series and 66 percent of the time in the PSI series.

TABLE 11. PERCENT OF HOUR WITH X AIRCRAFT BEING UPLINKED ADVISORIES

	X =										
SERIES	0	1	2	3	4	5	6	7	8	9	10
PSI	66.1	10.8	15.2	3.3	3.0	1.1	0.4	0.1	—	—	—
PSIV	60.8	7.7	18.5	5.3	4.3	1.7	0.8	0.4	0.2	0.2	0.1

CONCLUSIONS

Based on the results of the simulation tests, it is concluded that:

1. ATARS had no impact on the controllers or control procedures. Operations rates were consistently high, and no serious violation of ATC separation criteria occurred. Controllers used standard ATC control procedures and no increase in separation between aircraft was required to accommodate ATARS. The display of ATARS data to the controller did, however, introduce objectionable display clutter when uncontrolled aircraft were in encounters with controlled aircraft. The use of identical threat thresholds for both categories of aircraft, coupled with insufficient information regarding the intent of the uncontrolled aircraft, created a confusing display of flashing data blocks.

2. A further reduction of the Philadelphia main airport ATARS desensitization zones is warranted. The desensitization zone used in this study extended from the runway out to the outer marker. The results show that the length of this zone can be reduced to about half that and still eliminate virtually all undesirable ATARS alarms between arrival aircraft on converging ILS courses and between arrival aircraft and airport surface traffic.

3. Further studies are required to determine the need for ATARS desensitization at satellite airports. Two major factors to be considered are (1) the type of ATC service provided at the airport, and (2) the volume of traffic to be serviced. Under conditions of minimum ATC coverage and low density traffic at satellite airports, ATARS may provide a very effective separation assurance system without desensitization at the expense of only a few undesirable alarms.

4. ATARS provided adequate resolution to conflicting aircraft. ATARS detected all instances of potential conflict and provided resolution advisories to adequately separate aircraft.

5. The positive command rates were low under both IFR and VFR flight procedures. An average of only 0.5 encounters per hour involved positive commands. No positive commands were issued to aircraft inside the TCA.

6. ATARS advisories generated in the Philadelphia environment are primarily caused by the crossing route structure generated by the satellite airport traffic outside the TCA. All the command encounters except one occurred outside the TCA and involved at least one satellite aircraft. The one exception was from the PIV series in which no satellite aircraft were simulated and involved the use of VFR separation criteria.

7. A horizontal and vertical buffer is necessary to preclude a high number of undesirable alarms between controlled aircraft operating within the TCA and uncontrolled aircraft flying near the horizontal and vertical boundaires of the TCA. Without regulatory action to prevent uncontrolled aircraft from flying immediately at the boundaires of TCA's, ATRAS commands will inevitably cause some of these aircraft to penetrate TCA's.

8. Vertical tracker lag triggers advisories and/or continues them unnecessarily in cases where aircraft are leveling off above another aircraft. Although it was not apparent in any of the command encounters, tracker lag was responsible for seven of the thirteen encounters where only threat advisories were generated.

9. Although convergence/divergence logic did not significantly reduce alarm levels, it did shorten the duration of some command encounters. Four of the command encounters would have been reduced in duration by one or two command scans had the convergence/divergence filter been used. This filter eliminates alarms in circumstances where aircraft are violating ATARS alarm thresholds but are projected to be diverging in one dimension when at the closest point of approach in the other dimension.

RECOMMENDATIONS

1. The horizontal dimensions of the Philadelphia ATARS desensitization zones should be reduced so that they only extend to 2.0 nautical miles (nmi) from the threshold of the respective runways rather than all the way to the outer markers.

2. Allow uncontrolled aircraft operating around terminal control areas (TCA's) and in high density terminal areas, such as satellite airport environments, to receive threat and resolution advisories prior to controlled aircraft in order that the organization of controlled aircraft not be disturbed.

3. Some form of convergence/divergence logic should be incorporated into all future versions of the Automatic Traffic Advisory and Resolution Service (ATARS) algorithm. This logic looks at both the horizontal and vertical dimensions simultaneously to prohibit the generation of resolution advisories when the aircraft are projected to be in conflict in one dimension, but clearing in the other.

4. Investigate the possibility of reducing tracker lag by improving turn and climb/descent/level-off detection.

REFERENCES

1. Rossiter, S., Windle. J., Strack, R., and Mullen, W., Simulation Study of Intermittent Positive Control in a Terminal Area Air Traffic Control Environment, Report No. FAA-RD-76-193, January 1977.

2. Windle J., Morfitt G., Devine P., Rossiter S., and Fillius A., ATARS/ATC Simulation Tests with Site-Adaptation Logic, Report No. FAA-RD-78-138, January 1979.

3. McFarland, A. L., Patel, K. R., and Roberts, D. L., Multi-Site Intermittent Positive Control Algorithm for the Discrete Address Beacon System, Report No. FAA-EM-74-4, Change 2, May 1976.

4. IPC Site Adaptation Logic for DSF Testing, MITRE Corporation Memorandum to Dan Hopson, ARD-250, from Chen-Chung Hsin, August 8, 1977.

APPENDIX A

ATARS/PHILADELPHIA TRAFFIC

The construction of the traffic samples was based on an analysis of flight progress strips obtained from the Philadelphia TRACON. These strips were for 4 days of the first 6 months of 1977, during which the daily strip count ranged from 1,665 to 2,040. Further breakdown of this daily traffic to the busiest 16 hours provided a distribution of traffic by user, aircraft type, flight status, arrival/departure, and airport of operation.

Not all of the information for the VFR flights were available on the flight progress strips. Some operational interpretation and liberties were taken with this traffic. The controller, in most cases, handwrites a strip for VFR aircraft when they contact the facility for TCA entry clearance. This strip generally only indicates what instructions the controller issues and contains no preentry route data. Additionally, the Philadelphia TCA has no specific entry fixes published for VFR aircraft. The entry points used for these traffic samples, in general, conform to the normal IFR traffic flow without purposely mixing with that flow and reflect a consideration for the level of experience to be found in Philadelphia pilots.

Six different series of tests were designed to investigate the source and level of ATARS activity that might be expected to occur in the Philadelphia terminal area. These series are called PI, PIV, PSI, PSIV, NMC, and UNC. Five similar, but different, traffic samples were built for each series. One sample was used for training and four were used for data collection. The traffic samples used in each series of runs are summarized in tables A-1 through A-4. Table A-1 shows the total number of aircraft simulated in each series. The Philadelphia core traffic used in all data runs consisted of 75 aircraft of which 25 were general aviation (GA), 18 were air taxi (AT), and 32 were air carrier (AC).

TABLE A-1. TRAFFIC SAMPLE COUNTS

SERIES	AIRPORT		OVERFLIGHTS		
	PHL	SAT	CONTROLLED	UNC	TOTAL
PI	75	0	0	0	75
PIV	75	0	0	0	75
PSI	75	42	2	0	119
PSIV	75	42	9	0	126
NMC	75	42	9	0	126
UNC	75	42	9	25	151

TEST SERIES PI.

This series simulated the Philadelphia airport in an IFR situation. The runway configuration was easterly and only one runway (09R) was used for arrival operations. A parallel runway (09L) was used for high performance departure aircraft. Low performance aircraft were permitted to depart on runway 17. All 75 aircraft were flown under IFR separation criteria.

TEST SERIES PIV.

This series simulated the Philadelphia airport in a VFR situation with landings on runways 17 and 27R and departures on runways 17 and 27L. The traffic volume for this series was 75 operations per hour. Separation criteria applied between VFR/VFR aircraft and VFR/IFR aircraft was 1.5 nmi horizontal or 500 feet vertical. It was assumed that 50 percent of general aviation and air taxi operations were operating on VFR flight plans. The flight rule by aircraft user breakdown is shown in table A-2.

TABLE A-2. PHILADELPHIA IFR/VFR AIRPORT TRAFFIC

USER FLT RULE	VFR	IFR	TOTAL
General Aviation	13	12	25
Air Taxi	9	9	18
Air Carrier	0	32	32
Total	22	53	75

TEST SERIES PSI.

In series PI and PIV only the 75 aircraft were simulated. The PSI series introduced satellite operations to the environment and required additional controllers and increased coordination. As in series PI, all aircraft were considered to be operating in IFR conditions. Standard ATC separation criteria of at least 3 nmi horizontal or 1,000 feet vertical were applied between aircraft. The volume of aircraft was increased to 119 aircraft and included satellite operations and two overflights. The breakdown of the 42 satellite aircraft by airport, type, and flight rule is presented in table A-3.

TABLE A-3. SATELLITE AIRPORT TRAFFIC

AIRPORT		GA	AT	MIL	TOTAL	IFR	VFR
Greater Wilmington	(ILG)	11	4	0	15	5	10
North Philadelphia	(PNE)	8	4	0	12	6	6
Trenton	(TTN)	5	3	0	8	6	2
Willowgrove	(NXX)	0	0	5	5	5	0
Coatsville	(CVE)	2	0	0		2	0
Total		26	11	5	42	24	18

TEST SERIES PSIV.

This series is identical to the PSI series, except that seven VFR overflights are added for a total of 126 aircraft and VFR separation criteria is used where appropriate.

TEST SERIES NMC.

This series was established to vary the ATARS equipment capability of the participating aircraft. It used the same traffic as in the PSI series plus seven VFR overflights for a total of 126 aircraft. In tests PI, PIV, and PSI all aircraft were assumed to have DABS equipment with displays to accept ATARS PWI and resolution data. ATARS does not process data on aircraft without mode C altitude encoding capability, and in the initial period of ATARS implementation there is liable to be a considerable percentage of unequipped aircraft. The intent of this series was to determine what problems could be encountered in an environment of equipped and unequipped aircraft.

The distribution of ATCRBS mode A, ATCRBS mode C, and DABS was based on estimates of aircraft equipage for the 1980 time period obtained from SRDS DABS briefing material. For the purposes of this test series, it was assumed that all air carrier and scheduled air taxi flights would be equipped with DABS/ATARS equipment. For the general aviation population, it was assumed that 60 percent of the general aviation fleet would not have mode C altitude encoders. Of the 40 percent with mode C, it was decided that one-half might have complete DABS/ATARS and one-half ATCRBS mode C only. Table A-4 presents the aircraft equipage for the NMC series.

TABLE A-4. NMC SERIES AIRCRAFT EQUIPAGE

AIRPORT	AIR CARRIER DABS	AIR TAXI/MIL DABS	GENERAL AVIATION DABS	GENERAL AVIATION MODE A	GENERAL AVIATION ATCRBS MODE C	TOTAL ATCRBS
PHL	32	18	5	15	5	75
ILG	0	4	2	7	2	15
PNE	0	4	2	4	2	12
TTN	0	3	1	3	1	8
NXX	0	5(mil)	0	0	0	5
CVE	0	0	0	2	0	2
OVERFLTS	0	0	2	5	2	9
TOTAL	32	34	12	36	12	126

TEST SERIES UNC.

This series was designed to investigate the impact of uncontrolled aircraft operating in close proximity both horizontally and vertically to the TCA. The construction of the traffic sample was based on information gleaned from VFR flight plans obtained from the North Philadelphia Flight Service Station. This was the only available source of information short of a full-blown airport-by-airport interview of pilots. Since the requirement for filing a VFR flight plan is not mandatory, but only good operating practice, there was no guarantee that the flight plans obtained were completely representative. In fact, the filing of a VFR flight plan does not indicate uncontrolled flight but merely an intent to fly clear of clouds. Consequently, the uncontrolled aircraft in the UNC series present a combination of fact and postulation as to how a pilot might circumnavigate a TCA while maintaining his planned direction of flight.

The volume of traffic was the same as the NMC series except that 25 uncontrolled flights were added. The controller had no ability to communicate with these aircraft. All aircraft were DABS equipped, and the uncontrolled flights responded automatically to ATARS commands. When commands to an uncontrolled flight were discontinued, the aircraft was programmed to return to its original flightpath in the most appropriate manner.

APPENDIX B

A BRIEF DESCRIPTION OF THE ATARS ALGORITHM

The ATARS algorithm used in the simulation could generate four types of messages for delivery to the pilot and one message type for delivery to the controller. These messages are described as follows:

1. Proximity advisory or ordinary proximity warning indicator (OPWI).

Informs the pilot that another aircraft is nearby but not on a collision course. The intruder's relative bearing is depicted within a 30° relative bearing sector and relative altitude is indicated as above, below, or within 500 feet of its own altitude.

2. Threat advisory or flashing proximity warning indicator (FPWI).

Informs the pilot of a potential conflict and that a command may be issued if the present condition persists. It also contains the data provided by the OPWI.

3. Negative resolution advisory or negative command.

Negative commands may be effective or non-effective. An effective negative command requires the pilot to take action and stop an existing horizontal or vertical maneuver. A non-effective negative command informs the pilot that his present flightpath is safe, but that a conflict would develop if he were to maneuver in the indicated direction. Four negative advisories were provided, "do not turn left," "do not turn right," "do not descend," and "do not climb." Negative commands were always accompanied by an FPWI.

4. Positive resolution advisory or positive command.

Informs the pilot that a conflict exists which must be resolved by a maneuver. Four positive commands were provided, "turn right," "turn left," "climb," and "descend." Positive advisories were always accompanied by an FPWI.

5. Controller Alert.

The controller is provided with an alert whenever an FPWI, negative or positive advisory is issued to a pilot. The alert consists of a blinking character, in the third line of the aircraft's data block, which indicates the advisory being uplinked to the aircraft.

An aircraft can receive multiple threat and multiple resolution advisories; i.e., a pilot could receive positive horizontal and positive vertical advisories simultaneously.

The ATARS detection algorithm is described below in terms of the conditions required to generate each of the preceding messages.

1. OPWI's are issued to both aircraft whenever the altitude separation (ALT) and range separation (RANGE) between the two aircraft satisfy the following:

$$ALT < 2000 \text{ feet}$$

and

$$RANGE < \sqrt{2(V_1^2 + V_2^2)} \cdot 30 \text{ sec or Range} \quad 2 \text{ nmi}$$

where V_1 and V_2 are the speed of the two aircraft expressed in nmi/sec

2. FPWI's are issued to both aircraft whenever the following three conditions are satisfied:

a. Time to closest approach in the horizontal dimension (T_H or horizontal tau) < 45 sec;

where,

$$T_H = -\frac{R - DSQ/R}{R'}$$

R = Range separation
R' = Rate of change of Range
$DSQ = ADET\ (V_1^2 + V_2^2) + BDET$
$ADET = 7.5\ sec^2$
$BDET = 0.025\ nmi^2$

b. T_V (vertical tau) < 45 sec or ALT < 900'

where:

$$T_V = \frac{(Z_2 - Z_1)}{\dot{Z}_2 - \dot{Z}_1}$$

Z_2, Z_1 = altitudes of AC 2 and 1, respectively
$\dot{Z}_2$, $\dot{Z}_1$ = altitudes rates of AC 2 and 1, respectively

c. Horizontal Miss Distance (MD) < 1 nmi

3. Negative commands are issued to both aircraft whenever the following three conditions are satisfied:

a. $T_H < 30$ sec
b. $T_V < 30$ sec or ALT < 900'
c. MD < 1 nmi

4. Positive commands are issued to both aircraft whenever the following three conditions are satisfied:

a. $T_H < 30$ sec
b. $T_V < 30$ sec or ALT < 470 feet
c. MD < .5 nmi

5. Controller alerts are issued to the approprate ATC facility whenever the criteria for a FPWI are satisfied for a controlled aircraft. A listing of significant system parameters used in the algorithm are presented in table B-1.

TABLE B-1. PARAMETER VALUES

Parameter	Value
ADET	7.5 sec^2
AFCONI	470.0 ft
AFIFR	900.0 ft
BDET	0.025 nmi^2
MDTHF2	4.0 nmi^2
TCONT	45.0 sec
TL6	30.0 sec
TL11	45.0 sec
TL15	30.0 sec
TL16	45.0 sec

The parameters listed in table B-1 are defined as follows:

ADET, BDET--parameters used in the horizontal modified tau calculation,
AFCONI--altitude threshold for a controller alert in an IFR/IFR conflict,
AFIFR--altitude threshold for issuing a flashing PWI to an IFR aircraft,
MDTHF2--square of the projected miss distance threshold for issuing an FPWI,
TCONT--controller alert look-ahead time in the terminal area,
TL11--look-ahead time for issuing a flashing PWI when one aircraft is unequipped,
TL16--look-ahead time for issuing a flashing PWI when both aircraft are equipped,
TL6--look-ahead time for issuing an ATARS command when one aircraft is unequipped, and
TL15--look-ahead time for issuing an ATARS command when both aircraft are equipped.

APPENDIX C

ATARS COMMAND ENCOUNTERS

This appendix presents plots and descriptions of the nine ATARS encounters (one in PIV, four in PSI, and four in PSIV series), which resulted in positive or negative commands. Two plots are included for each encounter. One presents the encounter's horizontal profile and the second shows the encounter's vertical profile. Both axes of the horizontal plots are in nautical miles measured from the location of the radar. At Philadelphia, the radar is located just south of the threshold end of runway 09R. The aircraft identifications denote the starting locations of their respective tracks. The plus (+) symbol on an aircraft's track indicates the aircraft's actual position as recorded by the air traffic control simulation facility (ATCSF). The aircrafts' heading, as calculated by the ATARS algorithm, is shown by a straight line that emanates from the current position of the aircraft as perceived by the ATARS algorithm. The horizontal profile plots list the values of the closest point of approach in the horizontal plane (CPAH) in nmi, in the vertical plane (CPAV) in feet, and the slant range (SCPA) in nmi. The horizontal (SCPAH) and vertical (SCPAV) separations at the scan of minimum SCPA are also listed. For each scan of an encounter, the following information is printed: A symbol indicating the advisory issued to an aircraft; i.e., proximity (S for steady PWI) threat (F for FPWI), or resolution (negative and positive resolution advisories): the horizontal (TH) and vertical (TV) times to collision; the horizontal range between aircraft (range); the projected miss distance (MD); and the vertical separation (DZ).

The vertical profile plot uses time and altitude for its axes. The aircraft identifications, plus symbols, indicate the mode C altitude quantized in 100-foot increments. The position coordinates; i.e., X, Y, and Z, and heading (HDG) of each aircraft when the first threat advisory (FPWI) is generated are listed on the right side of the plot. For each scan of the encounter the following information is tabulated: the control status of each aircraft; i.e., controlled (C) or uncontrolled (U) horizontal velocity of each aircraft in knots and relative vertical velocity (VRZ) in feet/minutes. The issuance of a controller alert is indicated on both plots by an asterisk beside the appropriate scan number.

<u>ENCOUNTER NO. 1 - PIV-2.</u>

N3929L, a VFR departure climbing to 2,000 feet, and N3352U, a VFR arrival descending to 2,000 feet, momentarily triggered a two-scan FPWI after their horizontal paths had crossed but projected miss distance was within 1 nmi.

<u>ENCOUNTER NO. 2 - PSI-1.</u>

N7422A, an IFR departure from Philadelphia, was controlled by the north departure position. BLT721, an IFR departure from Newcastle, was controlled by the north satellite position. The aircraft were at coaltitude and converging in the horizontal plane when a controller alert was issued by ATARS. To prevent BLT721 from crossing in front of N7422A, the north satellite controller

turned BLT721 to the right so he would pass behind N7422A. The turn command "fly heading 120" was issued on the first "no left" command issued by the algorithm. The north departure controller issued a "descend and maintain 6,000" command to N7422A on the third FPWI.

When the first "no left" command was uplinked by ATARS, N7422A had crossed the projected path of BLT721 and had started to descend. Although the aircraft were still converging horizontally, the projected miss-distance and altitude separation were both increasing. The closest projected miss-distance, 0.93 nmi, occurred on the third FPWI. The aircraft came within 1.3 nmi and 190 feet on the last scan of "no left" commands. The violation of ATC separation standards was attributed to controller coordination problems.

ENCOUNTER NO. 3 - PSI-2.

N6101, an IFR Newcastle arrival, was level at 4,000 feet flying a heading of 180°. N7864K, an overflight having descended from 4,000, was level at 3,000 feet also on a heading of 180°. The north approach controller instructed N7864K to "climb and maintain 6,000, fly heading 240" which caused N7864K to follow a collision course with N6101. On scan 896 control of N6101 was transferred from the north satellite controller to the south departure controller. Two scans later, scan 898, FPWI's were issued to both aircraft. The aircraft continued to converge in both dimensions until ATARS issued climb commands to N6101 and dive commands to N7864K and the aircraft responded to the commands. Minimum projected miss-distance during the 10-scan encounter was 0.28 nmi. At the end of the encounter the aircraft were separated by 0.34 nmi, and 468 feet. When the first vertical command was uplinked, the aircraft were separated by 1.51 nmi, and 380 feet. Violation of ATC separation standards was attributed to controller coordination problems and ATARS issued an appropriate resolution maneuver to separate the aircraft.

ENCOUNTER NO. 4 - PSI-4.

N7763T, an IFR arrival to Newcastle, and N6528N, an IFR departure from Newcastle, were involved in an encounter which resulted in eight scans of FPWI's and one scan of a "no left" command. Both aircraft were controlled by the south departure position. At the time of the conflict, N5528N was climbing to 5,000 feet at maximum rate and N7763T had leveled off at 3,000 feet. They were flying headings of 270 and 180°, respectively. The aircraft were diverging in the vertical plane after the second scan of FPWI when the horizontal separation was 1.91 nmi.

ENCOUNTER NO. 5 - PSI-7.

N8781U, an IFR departure from North Philadelphia, and V48211, an IFR arrival to NXX, were at coaltitude and converging horizontally at about a 90° crossing angle when the ATARS was triggered. Both aircraft were controlled by the North satellite position. The aircraft were converging until horizontal separation was 1.28 nmi at which time they started to diverge vertically.

ENCOUNTER NO. 6 - PSIV-1.

N75500, a VFR arrival to Trenton (TTN) had been cleared for an ILS approach to runway 7, level at 1,500 feet, and was flying a heading of 090°. RAN557, a VFR arrival to North Philadelphia (PNE) had been cleared for an ILS approach to runway 24, was descending through the altitude of N75500, and was flying a heading of 240°. When the first negative right command was generated, the aircraft were separated by 2.46 nmi and 70 feet. Closest point of approach was 1.75 nmi. When the two aircraft received the negative commands, they both executed missed approaches and started to climb.

ENCOUNTER NO. 7 - PSIV-2.

N3029, a VFR departure from Newcastle (ILG) was level at 3,500 feet on a heading of 010°. N3305V, a VFR arrival to Newcastle (ILG) was descending to 3,500 feet on a heading of 160°. At the time the FPWI's were uplinked, the aircraft were coaltitude at 3,500 feet and converging horizontally. When the fourth of five FPWI's was uplinked, the aircraft were at coaltitude and separated by 2.6 nmi. It was at this time, scan 790, that the departure controller, who was controlling both aircraft, instructed N3305V to fly heading 270° and descend to 2,500 feet at its maximum rate. The ATARS uplinked positive vertical commands to the aircraft on scan 792. The ATARS command to N3305V was completely opposite to the controller's instructions. That is, the ATARS issued a climb command to N3305V, whereas the controller had issued a dive command. The ATCSF/ATARS was *designed* to allow the controller instruction to take precedence over the ATARS command.

ENCOUNTER NO. 8 - PSIV-5.

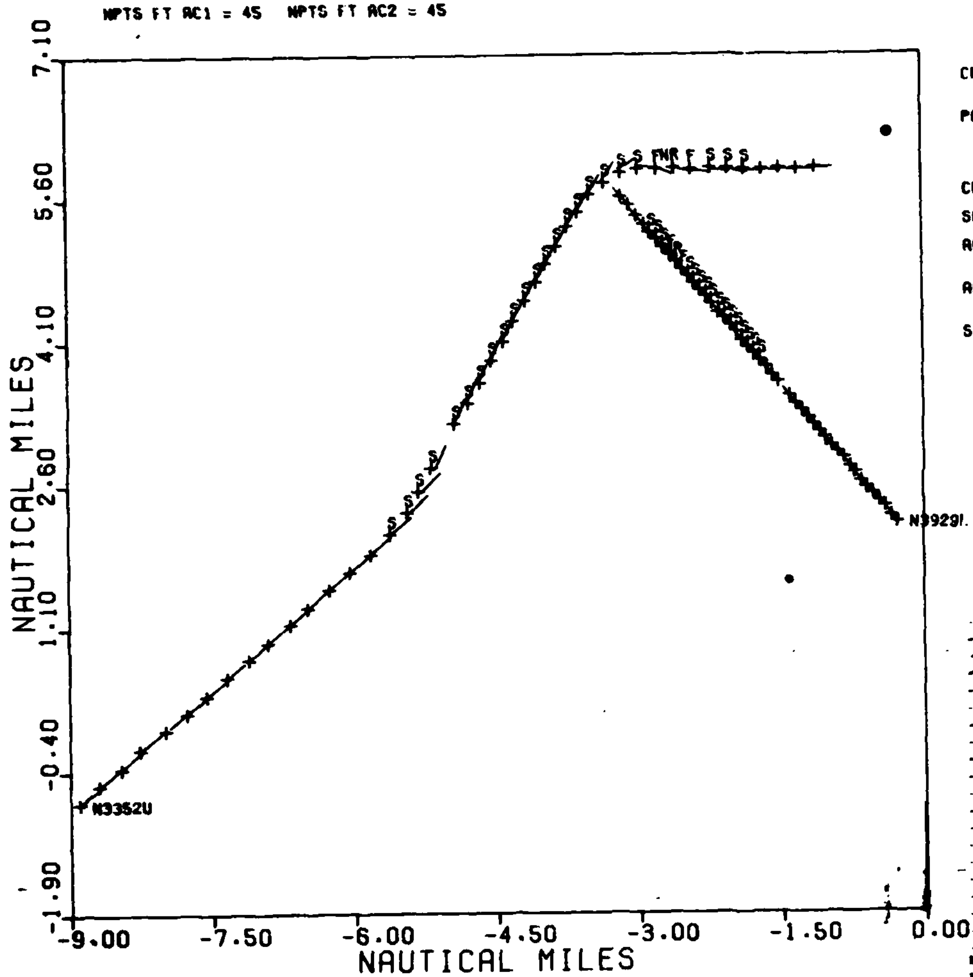
N9206, a VFR arrival to runway 17 at Philadelphia was flying on a heading of 350°. N5223N, a VFR through flight, was on an intercepting heading of 080°. Both aircraft were at a coaltitude of 3,500 feet. ATARS uplinked FPWI's to both aircraft starting on scan 639. On scan 641, as the third FPWI was being uplinked, the TCA controller instructed N9206 to descend and maintain 2,500 feet. After uplinking 5 scans of FPWI's, ATARS started uplinking 4 scans of positive vertical commands. The aircraft had started to diverge vertically because of the TCA controller instructions when the first positive command was uplinked.

ENCOUNTER NO. 9 - PSIV-7.

N3087V, a VFR approach to Newcastle (ILS), was level at 6,500 feet on a heading of 210°. TW118, an IFR approach to runway 27R at Philadelphia, was descending to 7,000 feet on a heading of 100°. As TW118 leveled off, the alarm was sounded. Vertical tracker lag was responsible for the alarm. No ATC violation had occurred. At closest point of approach, the aircraft were separated by 0.58 nmi and 503 feet.

START TIME = 10 48 0   END TIME = 10 51 1   ST SCAN = 895   END SCAN = 931   ENCOUNTER NUMBER 1 PIV-2

NPTS FT AC1 = 45   NPTS FT AC2 = 45



CPAH = 0.915   CPAV = 16.920

POSCMD= 0   AT SCAN 0   MD= 0.000
ALT= 0.0   XANG= 0.00

CPA ON SCAN 924   SCPA = 0.915
SCPAH = 0.915   SCPAV = 32.649
AC1 ID = N3352U   CON DABS

AC2 ID = N39291.   CON DABS

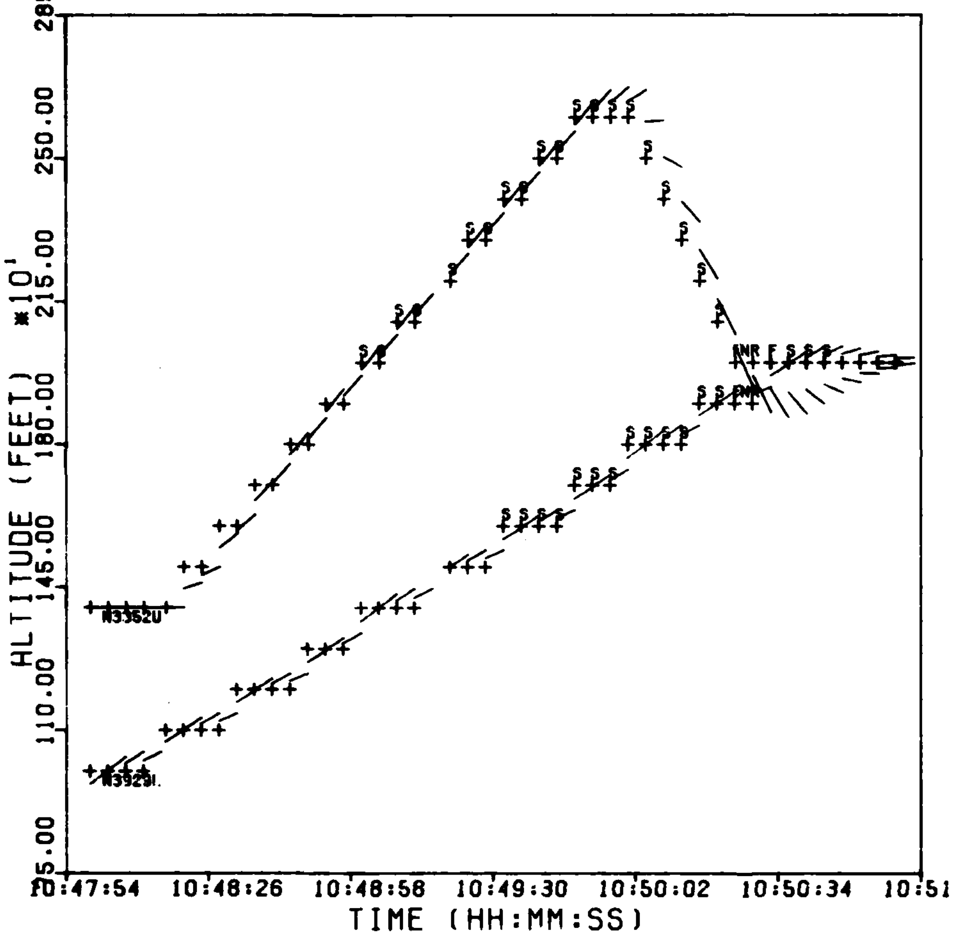
SCAN	AC1	AC2	POS	TH	RANGE	MD	TV	RZ
895				120	9.11	0.42	52	-433
896				116	8.92	0.47	48	-400
897				112	8.51	0.36	53	-382
889				109	8.22	0.43	69	-375
890				112	7.80	0.19	45	-328
891				112	7.55	0.03	92	-346
892				109	7.27	0.06	280	-363
893				104	6.98	0.08	-110	-424
894				98	6.67	0.18	-172	-421
895				92	6.39	0.18	-94	-463
896				86	6.07	0.27	-88	-491
897				81	5.78	0.37	-84	-553
898				75	5.48	0.39	-89	-547
899				71	5.18	0.44	-89	-584
900				66	4.88	0.46	-97	-605
901	S			61	4.58	0.53	-119	-616
902	S			59	4.29	0.68	-162	-620
903	S			56	4.05	0.88	-108	-665
904	S			68	3.83	1.97	-106	-695
906	S			69	3.44	2.12	-159	-718
907	S			67	3.24	2.08	-112	-768
908	S			65	3.04	1.98	-113	-798
909	S	S		63	2.84	1.92	-131	-813
910	S	S		60	2.65	1.83	-170	-820
911	S	S		60	2.49	1.80	-124	-868
912	S	S		61	2.33	1.77	-126	-898
913	S	S		61	2.18	1.72	-147	-914
914	S	S		64	2.06	1.70	-192	-921
915	S	S		68	1.93	1.66	-274	-921
916	S	S		79	1.83	1.68	594	-872
917	S	S		87	1.72	1.61	105	-789
918	S	S		109	1.64	1.59	52	-885
919	S	S		139	1.54	99.00	32	-571
920	S	S		54	1.42	1.29	16	-407
921	S	S	-2	25	1.27	0.90	9	-267
922	F	F	0	20	1.10	-0.77	4	-122
923	NR	NR		33	0.98	0.90	2	-46
924	F	F		90	0.92	0.91	-1	33
926	S	S		310	0.95	99.00	-4	70
926	S	S		374	1.04	99.00	-6	80
927	S	S		493	1.19	99.00	-8	74

PRT/PLT PD2 PIV1 11 JUL 78 AC1 N3352U   AC2 N3929L   ATARS SAMPLE : ATARS PHL TEST

ATARS VERS. NTAC-4.5   NAFEC VERSION 2.0

START TIME = 10 48 0   END TIME = 10 51 1   ST SCAN = 895   END SCAN = G   ENCOUNTER NUMBER 1 PIV-2

NPTS FT AC1 = 45   NPTS FT AC2 = 45



PRT/PLT PD2 PIV1 11 JUL 78 AC1 N3352U   AC2 N3929I   ATARS SAMPLE : ATARS PHL TEST

ATARS VERS. NTAC-4.5   NAFEC VERSION 2.0

FIRST FLASHING ON SCAN 922

AC1 ID = N3352U   CON DABS

X = -2.78   Y = 5.92

Z = 2039   HDG = 113

AC2 ID = N3929I   CON DABS

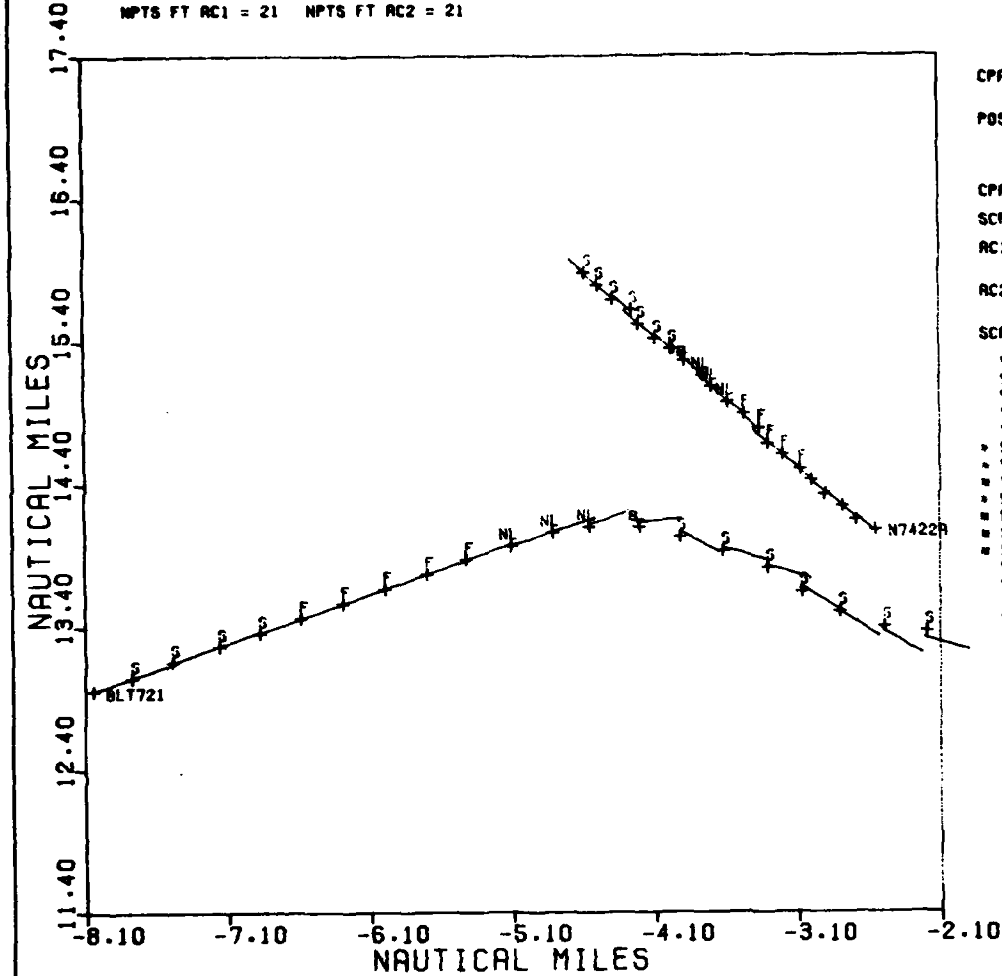
X = -2.51   Y = 4.85

Z = 1916   HDG = 320

SCAN	AC1	AC2	VEL1	VEL2	VRZ	DOT	TCMD
895	C	C	261	84	503	-2495	30
886	C	C	259	84	502	-2403	30
897	C	C	259	86	429	-2319	30
899	C	C	258	96	328	-2226	30
890	C	C	235	96	443	-1956	30
891	C	C	225	96	224	-1826	30
892	C	C	221	85	75	-1737	30
893	C	C	223	97	-232	-1676	30
994	C	C	229	96	-147	-1637	30
895	C	C	233	99	-296	-1597	30
996	C	C	240	87	-334	-1546	30
897	C	C	242	86	-522	-1487	30
898	C	C	247	87	-331	-1431	30
999	C	C	250	88	-398	-1365	30
900	C	C	253	96	-376	-1297	30
901	C	C	256	96	-310	-1224	30
902	C	C	258	96	-230	-1141	30
903	C	C	255	96	-370	-1044	30
904	C	C	253	97	-392	-770	30
906	C	C	250	87	-273	-615	30
907	C	C	247	86	-410	-556	30
908	C	C	243	97	-425	-507	30
909	C	C	239	89	-371	-459	30
910	C	C	235	98	-289	-415	30
911	C	C	230	99	-419	-367	30
912	C	C	226	87	-429	-319	30
913	C	C	222	87	-372	-277	30
914	C	C	217	86	-289	-234	30
915	C	C	211	87	-202	-195	30
916	C	C	208	96	90	-151	30
917	C	C	202	87	449	-120	30
918	C	C	199	88	793	-87	30
919	C	C	194	89	1079	-60	99999
920	C	C	188	99	1509	-132	30
921	C	C	185	97	1739	-229	30
■ 922	C	C	186	87	1827	-211	30
■ 923	C	C	186	87	1611	-99	30
924	C	C	184	87	-1480	-32	30
925	C	C	182	89	-1196	42	99999
926	C	C	179	90	-872	111	99999
927	C	C	174	91	-572	176	99999

START TIME = 10 47 49 END TIME = 10 49 9 ST SCAN = 993 END SCAN = 903 ENCOUNTER NUMBER 2 PSI-1

NPTS FT AC1 = 21 NPTS FT AC2 = 21



CPAH = 1.179 CPAV = 0.000

POSCMD= 0 AT SCAN 0 MD= 0.000
ALT= 0 0 XANG= 0.00

CPA ON SCAN 996 SCPA = 1.179
SCPAH = 1.179 SCPAV = 260.939
AC1 ID = BLT721 CON DASS

AC2 ID = N7422A CON DASS

SCAN	AC1	AC2	POS	TH	RANGE	MD	TV	RZ
993				59	5.53	1.00	0	0
994	S			54	5.21	0.99	0	0
995	S			50	4.93	0.97	0	0
996	S			45	4.41	0.9[illegible]	0	0
997	S			41	4.02	0.95	0	0
* 999	F	F		38	3.65	0.9[illegible]	0	0
* 999	F	F		34	3.27	0.9[illegible]	0	0
* 990	F	F		30	2.89	0.93	0	0
* 991	F	F	-2	27	2.53	0.96	0	0
* 892	F	F	0	25	2.19	0.96	-13	-46
* 993	NL	NL	0	22	1.84	0.97	-16	-79
* 594	NL	NL	0	20	1.52	1.00	-17	-146
995	NL	NL	0	21	1.30	1.04	-20	-190
996	S	S		96	1.18	1.17	-22	-261
997	S	S		557	1.29	99.00	-26	-305
998	S	S		933	1.55	99.00	-28	-374
999	S	S		999	1.91	99.00	-33	-415
900	S	S		999	2.30	99.00	-43	-435
901	S	S		999	2.71	99.00	-44	-487
902	S	S		999	3.12	99.00	-52	-516
903	S	S		999	3.49	99.00	-53	-576

PRT/PLT ATARS 4 JUN 79 AC1 BLT721 AC2 N7422A ATARS SAMPLE : PHL PD10 PSI-1

ATARS VERS. NTAC-4.5 NAFEC VERSION 2.0

1

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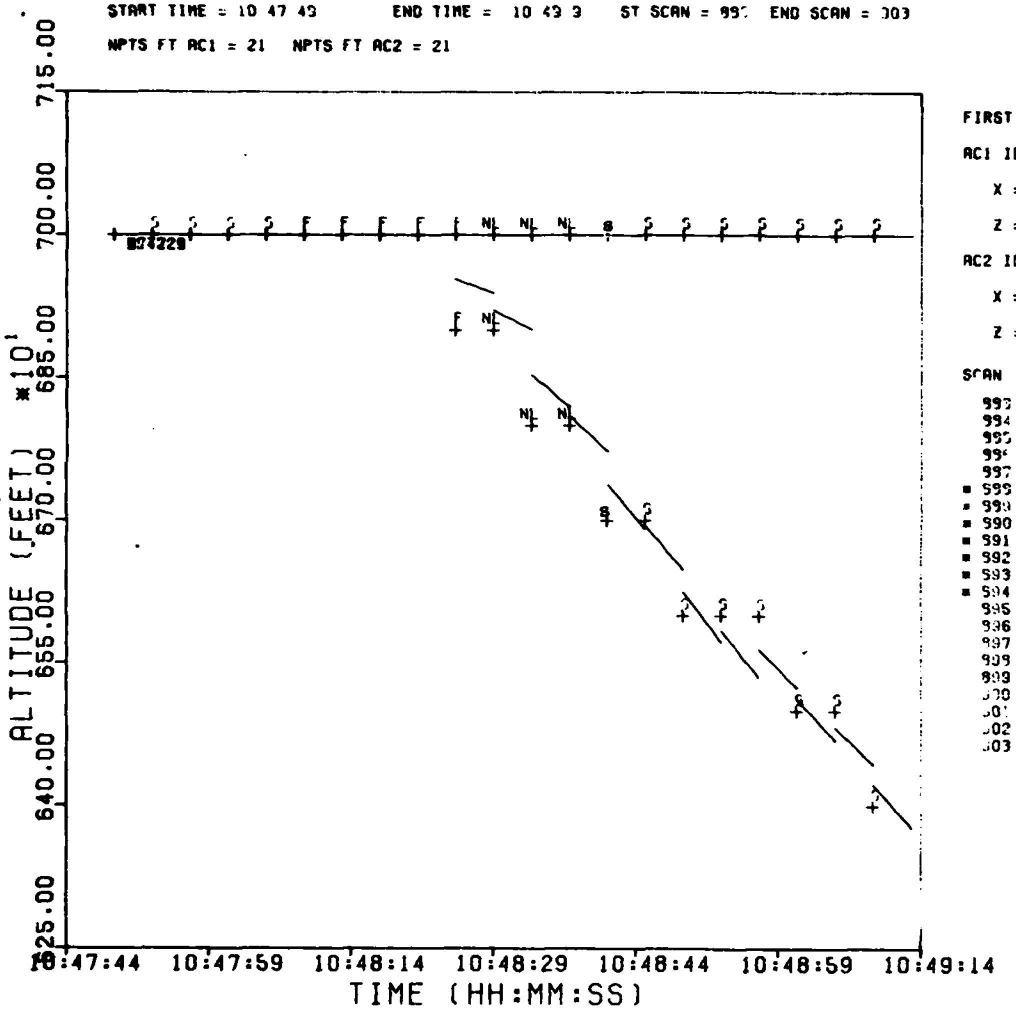
START TIME = 10 47 43 END TIME = 10 49 3 ST SCAN = 993 END SCAN = 303

NPTS FT AC1 = 21 NPTS FT AC2 = 21

ENCOUNTER NUMBER 2 PSI-1



FIRST FLASHING ON SCAN 995

AC1 ID = BLT721 CON DABS

X = -6.59 Y = 13.46

Z = 7000 HDG = 71

AC2 ID = N74229 CON DABS

X = -3.09 Y = 14.51

Z = 7000 HDG = 311

SCAN	AC1	AC2	VEL1	VEL2	VRZ	DOT	TCMD
993	C	C	279	123	-0	-1938	30
994	C	C	277	123	-0	-1904	30
995	C	C	275	122	-0	-1662	30
996	C	C	279	123	-0	-1652	30
997	C	C	279	124	-0	-1397	30
* 998	C	C	280	122	-0	-1257	30
* 999	C	C	280	122	-0	-1115	30
* 990	C	C	280	122	-0	-975	30
* 991	C	C	281	121	-0	-831	30
* 992	C	C	280	121	-216	-693	30
* 993	C	C	280	121	-301	-550	30
* 994	C	C	280	123	-519	-405	30
995	C	C	275	121	-561	-273	30
996	C	C	275	123	-719	-50	30
997	C	C	275	123	-700	233	99999
998	C	C	278	122	-80[illegible]	378	99999
999	C	C	283	123	-745	500	99999
300	C	C	282	121	-676	853	99999
301	C	C	283	121	-660	1033	99999
302	C	C	284	122	-634	1219	99999
303	C	C	280	121	-699	1263	99999

PRT/PLT ATARS 4 JUN 79 AC1 BLT721 AC2 N74229 ATARS SAMPLE : TH. PDIO PSI-1

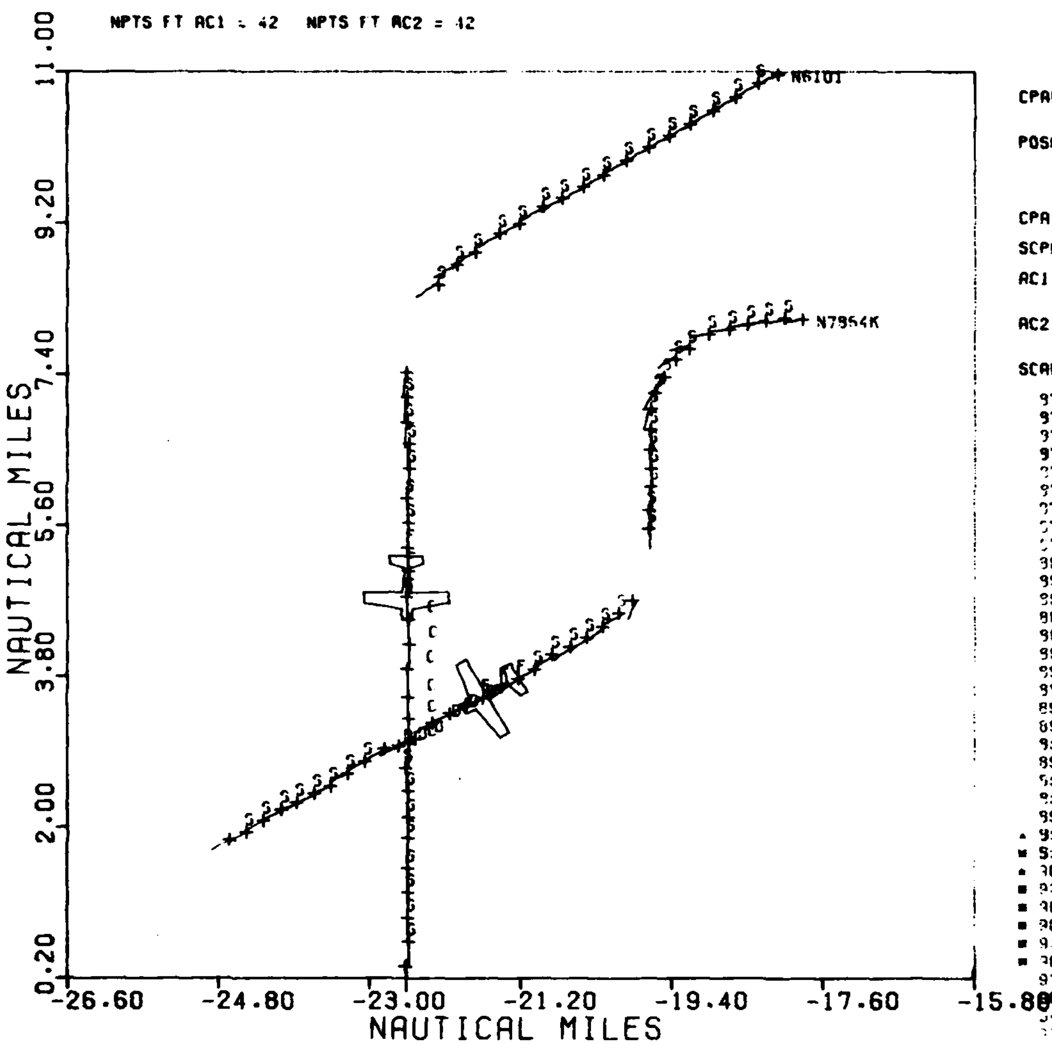
ATARS VERS. NTAC-4.5 NAFEC VERSION 2.0

2

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDC

START TIME = 10 47 1   END TIME = 10 49 57   ST SCAN = 971   END SCAN = 915   ENCOUNTER NUMBER 3 PSI-2

NPTS FT AC1 = 42   NPTS FT AC2 = 42



PRT/PLT ATARS 4 JUN 73 AC1 N6101   AC2 N7954K   ATARS SAMPLE : PHL PD10 PSI-1

ATARS VERS. NTAC-4.5   NAFEC VERSION 2.0

CPAH = 0.310   CPAV = 263.909

POSCMD= 1   AT SCAN 900 MD= 0.329
ALT= 390.0 XANG= 54.92

CPA ON SCAN 906   SCPA = 0.318
SCPAH = 0.310   SCPAV = 641.800
AC1 ID = N6101   CON CASS

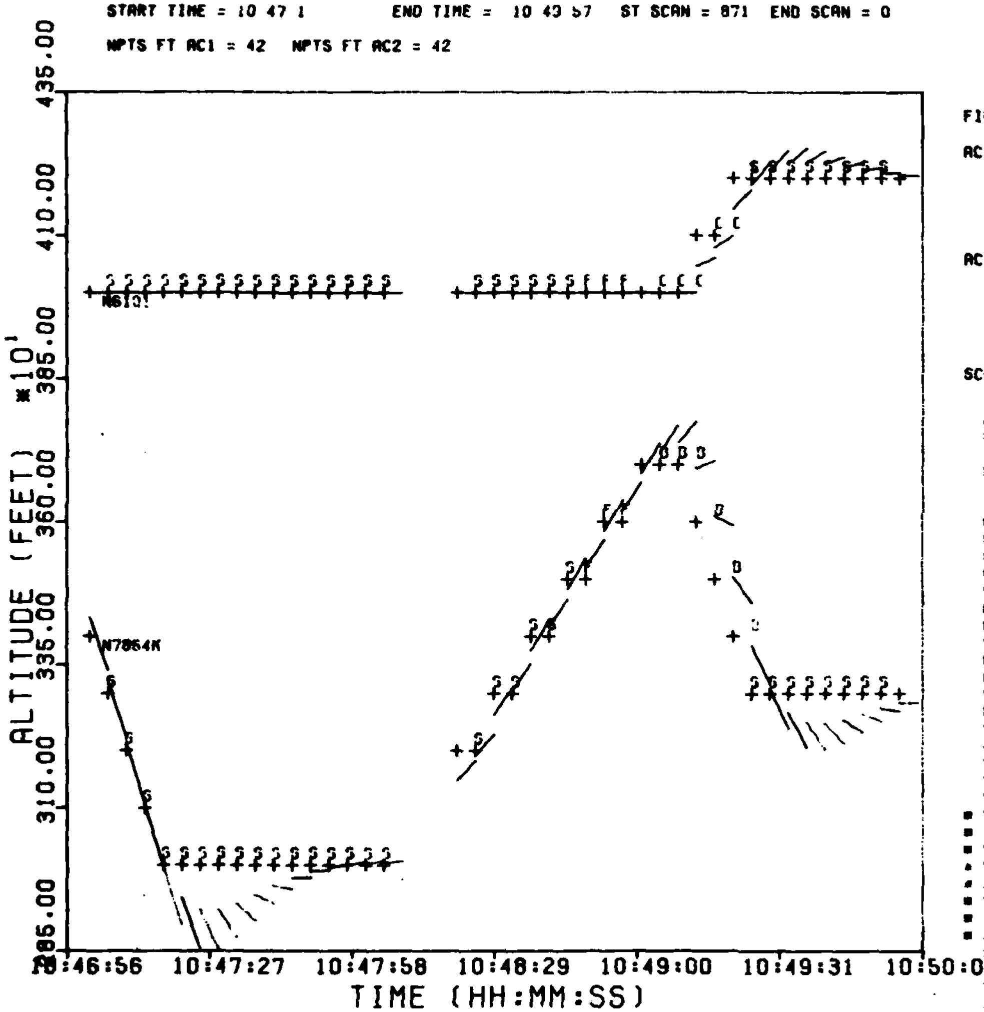
AC2 ID = N7954K   CON CASS

SCAN	AC1	AC2	POS	TH	RANGE	MD	TV	RZ
971				118	3.33	0.89	-21	-556
972	S	S		111	2.80	0.85	-27	-679
973	S	S		103	2.70	0.90	-31	-789
974	S	S		96	2.59	0.99	-34	-896
975	S	S		94	2.49	1.11	-39	-1000
976	S	S		94	2.40	99.00	-47	-1056
977	S	S		111	2.41	99.00	-63	-1078
978	S	S		999	2.40	99.00	-91	-1078
979	S	S		999	2.47	99.00	-146	-1067
980	S	S		999	2.58	99.00	-275	-1052
981	S	S		999	2.71	99.00	-733	-1039
982	S	S		999	2.92	99.00	999	-1022
983	S	S		999	3.11	99.00	999	-1012
984	S	S		999	3.33	99.00	955	-1024
985	S	S		999	3.51	99.00	959	-1000
986	S	S		999	3.72	99.00	999	-997
987	S	S		999	3.87	99.00	999	-995
891				146	3.89	99.00	98	-853
892	S	S		55	3.65	0.12	87	-809
893	S	S		60	3.39	0.18	62	-739
894	S	S		52	3.14	0.38	60	-695
895	S	S		46	2.89	0.42	47	-626
896	S	S		39	2.57	0.32	47	-585
897	S	S		34	2.31	0.35	39	-519
▲ 898	F	F		30	2.04	0.34	39	-481
■ 899	F	F	-2	25	1.77	0.33	31	-417
▲ 900	F	F	1	21	1.51	0.32	31	-380
■ 901	C	D	1	17	1.23	0.32	24	-317
■ 902	C	D	1	13	0.96	0.30	23	-280
■ 903	C	D	1	9	0.71	0.28	20	-264
■ 904	C	D	1	6	0.43	0.31	999	-353
■ 905	C	D	1	3	0.34	0.32	-51	-468
906	C	S		2	0.31	99.00	-32	-642
907	S	S		55	0.43	99.00	-31	-824
908	S	S		166	0.74	99.00	-35	-905
909	S	S		323	0.99	99.00	-44	-959
910	S	S		539	1.27	99.00	-59	-978
911	S	S		707	1.53	99.00	-85	-978
912	S	S		995	1.82	99.00	-137	-966
913	S	S		999	2.07	99.00	-261	-951
914	S	S		999	2.31	99.00	-723	-935

START TIME = 10 47 1 END TIME = 10 43 57 ST SCAN = 871 END SCAN = 0

NPTS FT AC1 = 42 NPTS FT AC2 = 42

ENCOUNTER NUMBER 3 PSI-2



PRT/PLT ATARS 4 JUN 79 AC1 N6101 AC2 N7864K ATARS SAMPLE : PHL PD10 PSI-1

ATARS VERS. NTAC-4.5 NAFEC VERSION 2.0

FIRST FLASHING ON SCAN 998

AC1 ID = N6101 CON DABS

X = -22.54 Y = 5.33

Z = 4000 HDG = 179

AC2 ID = N7864K CON DABS

X = -21.22 Y = 3.77

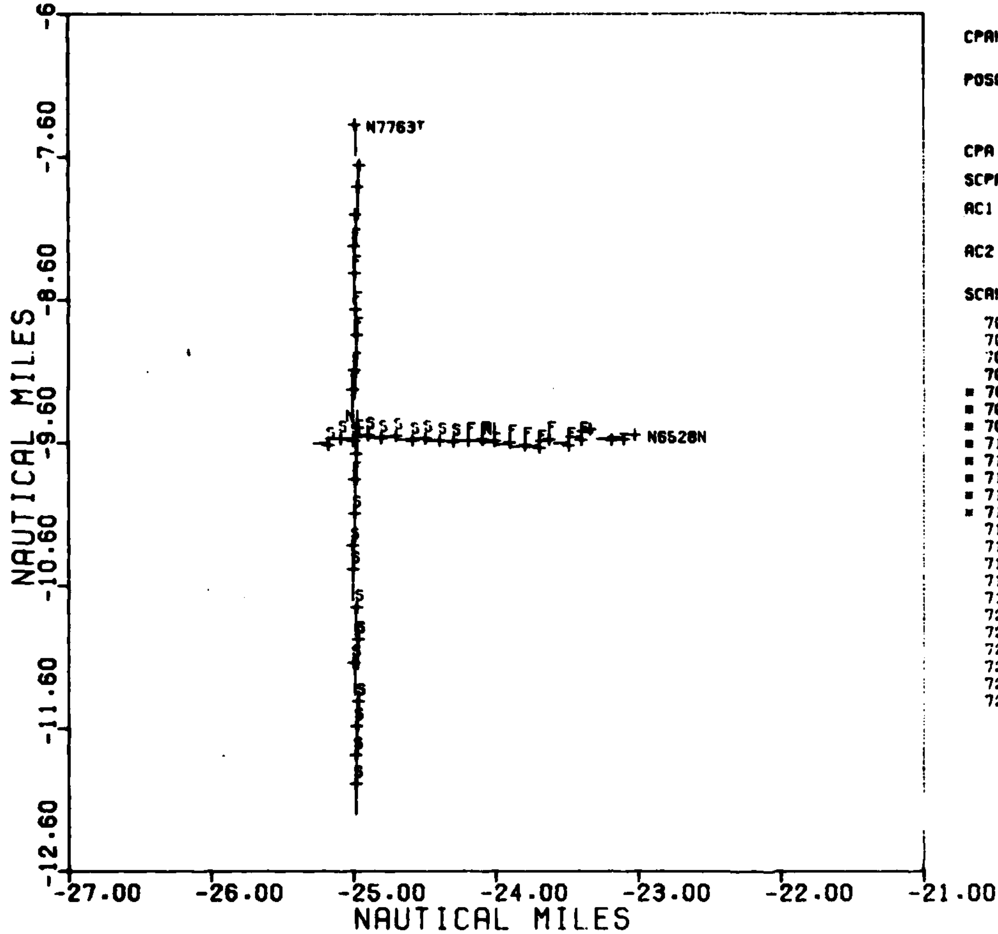
Z = 3519 HDG = 239

SCAN	AC1	AC2	VEL1	VEL2	VRZ	DOT	TCMD
871	C	C	264	214	-1419	-281	30
872	C	C	261	212	-1505	-265	30
873	C	C	262	210	-1550	-261	30
974	C	C	265	208	-1567	-246	30
875	C	C	268	206	-1567	-233	30
876	C	C	268	206	-1341	-218	99999
977	C	C	267	210	-1027	-184	99999
878	C	C	267	209	-711	-10	99999
979	C	C	270	212	-439	281	99999
990	C	C	269	216	-230	212	99999
981	C	C	268	214	-85	362	99999
982	C	C	263	215	5	566	99999
893	C	C	264	218	53	538	99999
894	C	C	262	218	71	675	99999
885	C	C	268	215	70	728	99999
896	C	C	268	217	60	780	99999
897	C	C	270	217	45	786	99999
991	C	C	266	204	522	-372	99999
892	C	C	271	204	561	-867	30
993	C	C	274	210	716	-689	30
894	C	C	271	214	697	-675	30
995	C	C	269	215	802	-645	30
896	C	C	273	215	743	-608	30
997	C	C	275	218	920	-556	30
■ 898	C	C	275	218	743	-496	30
■ 899	C	C	272	216	911	-432	30
■ 900	C	C	271	217	731	-368	30
■ 901	C	C	267	214	798	-297	30
■ 902	C	C	265	212	720	-228	30
■ 903	C	C	264	210	574	-162	30
■ 904	C	C	269	213	-19	-95	30
■ 905	C	C	265	213	-650	-29	30
906	C	C	264	206	-1187	39	99999
907	C	C	264	206	-1574	101	99999
908	C	C	262	208	-1555	164	99999
909	C	C	263	212	-1320	226	99999
910	C	C	253	211	-1005	284	99999
911	C	C	264	211	-681	362	99999
912	C	C	266	209	-423	433	99999
913	C	C	268	208	-219	503	99993
914	C	C	268	209	-78	563	99993

START TIME = 10 36 52   END TIME = 10 37 20   ST SCAN = 703   END SCAN = 725

NPTS FT AC1 = 23   NPTS FT AC2 = 23

ENCOUNTER NUMBER 4 PSI-4



CPAH = 0.846   CPAV = 8.311

POSCMD= 0   AT SCAN 0   MD= 0.000

ALT= 0.0   XANO= 0.00

CPA ON SCAN 715   SCPA = 0.848

SCPAH = 0.846   SCPAV = 308.687

AC1 ID = N7763T   CON CABS

AC2 ID = N6528N   CON CABS

	SCAN	AC1	AC2	POS	TH	RANGE	MD	TV	RZ
	703				51	2.92	0.84	14	-153
	704				47	2.68	0.87	9	-105
	705				45	2.50	0.87	8	-79
	706				41	2.25	0.86	9	-68
*	707	F	F		39	2.08	0.88	2	-20
*	708	F	F		38	1.91	0.86	-1	8
*	709	F	F		33	1.66	0.84	-7	69
*	710	F	F		31	1.50	0.81	-10	106
*	711	F	F	-2	30	1.31	0.84	-15	125
*	712	F	F	0	29	1.15	0.84	-18	178
*	713	NL	NL		30	0.98	0.83	-23	209
*	714	F	F		44	0.89	0.84	-24	271
	715	F	F		131	0.85	99.00	-29	309
	716	S	S		248	0.86	99.00	-37	327
	717	S	S		306	0.95	99.00	-37	380
	718	S	S		383	1.06	99.00	-44	411
	719	S	S		522	1.22	99.00	-42	472
	720	S	S		723	1.44	99.00	-48	509
	721	S	S		903	1.60	99.00	-60	528
	722	S	S		989	1.85	99.00	-57	580
	723	S	S		999	2.02	99.00	-65	611
	724	S	S		999	2.22	99.00	-60	672
	725	S	S		999	2.40	99.00	-67	709

PRT/PLT ATARS 4 JUN 79 AC1 N7763T   AC2 N6528N   ATARS SAMPLE , PHL PD11 PSI-2

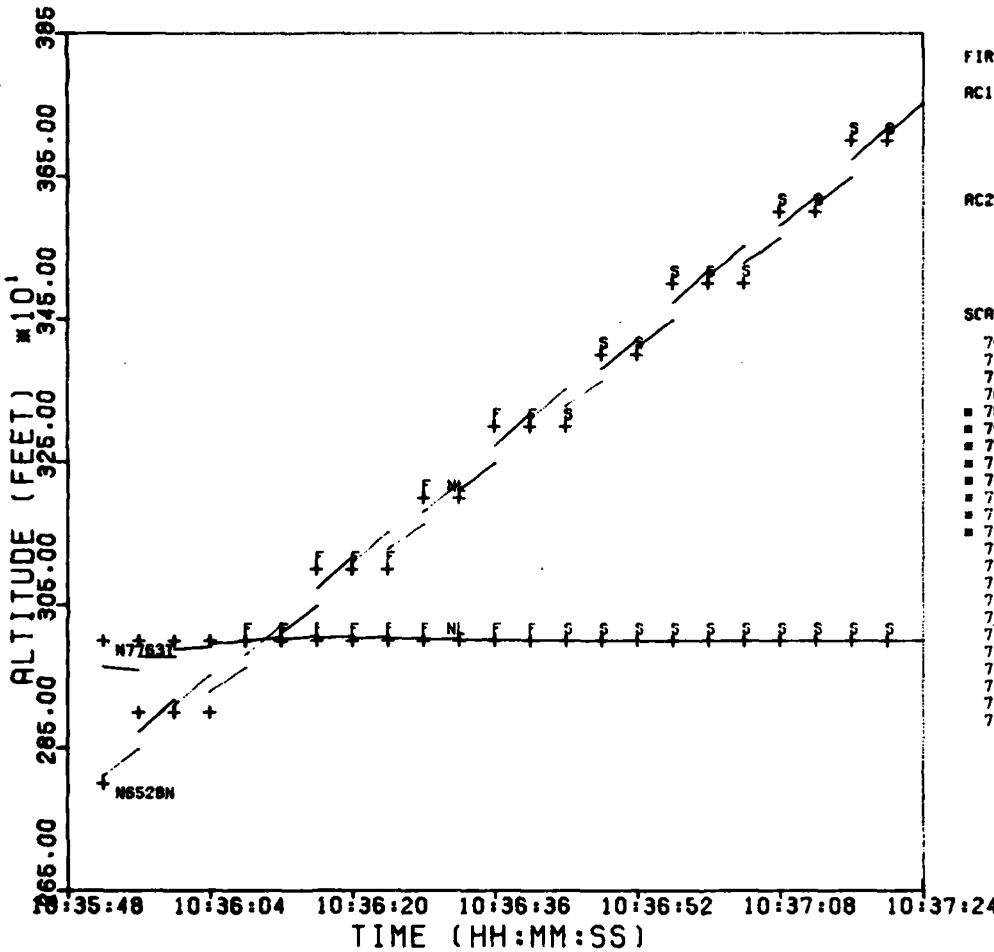
ATARS VERS. NTAC-4.5   NAFEC VERSION 2.0

1

START TIME = 10 35 52   END TIME = 10 37 20   ST SCAN = 703   END SCAN = 725

NPTS FT AC1 = 23   NPTS FT AC2 = 23

ENCOUNTER NUMBER 4 PSI-4



FIRST FLASHING ON SCAN 707

AC1 ID = N7763T   CON DABS

X = -24.99   Y = -8.22

Z = 3000   HDG = 181

AC2 ID = N6520N   CON DABS

X = -23.40   Y = -9.56

Z = 298C   HDG = 272

SCAN	AC1	AC2	VEL1	VEL2	VRZ	DOT	TCMD
703	C	C	187	92	646	-598	30
704	C	C	192	90	660	-549	30
705	C	C	190	88	583	-494	30
706	C	C	187	91	454	-444	30
■ 707	C	C	187	90	535	-392	30
■ 708	C	C	185	88	502	-341	30
■ 709	C	C	188	90	620	-293	30
■ 710	C	C	187	89	605	-251	30
■ 711	C	C	190	88	506	-202	30
■ 712	C	C	185	89	595	-159	30
■ 713	C	C	188	90	558	-108	30
■ 714	C	C	187	89	673	-61	30
715	C	C	184	89	638	-18	99999
716	C	C	185	89	520	31	99999
717	C	C	188	89	608	84	99999
718	C	C	185	99	564	129	99999
719	C	C	189	88	675	186	99999
720	C	C	193	90	637	252	99999
721	C	C	191	91	525	292	99999
722	C	C	194	91	606	361	99999
723	C	C	193	91	-562	395	99999
724	C	C	191	90	-673	436	99999
725	C	C	189	98	-636	480	99999

PRT/PLT ATARS 4 JUN 79 AC1 N7763T   AC2 N6520N   ATARS SAMPLE : PHL PD11 PSI-2

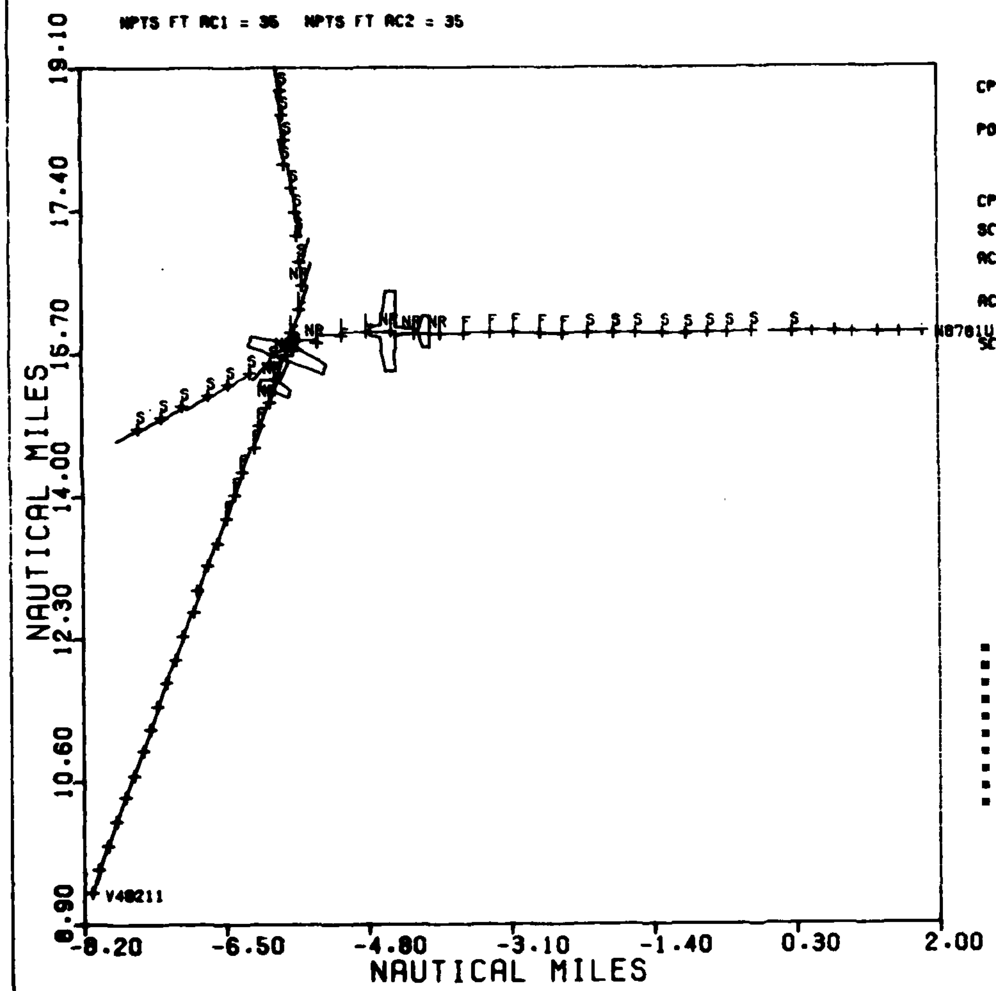
ATARS VERS. NTAC-4.5   NAFEC VERSION 2.0

2

START TIME = 10 26 1 END TIME = 10 28 17 ST SCAN = 556 END SCAN = 590

ENCOUNTER NUMBER 5 PSI-7

NPTS FT AC1 = 36 NPTS FT AC2 = 35



CPAH = 0.586 CPAV = 1.853

POSCMD= 1 AT SCAN 579 MD= 0.483

ALT= 43.8 XANG= 249.79

CPA ON SCAN 591 SCPA = 0.589

SCPAH = 0.586 ~~SCPAV = 817.232~~

AC1 ID = V48211 CON DABS

AC2 ID = N8781U CON DABS

	SCAN	AC1	AC2	POS	TM	RANGE	MD	TV	RZ
	556				99	11.95	0.33	75	-1618
	557				96	11.49	0.37	56	-1471
	558				93	11.04	0.43	30	-1196
	559				89	10.55	0.47	17	-881
	560				86	10.11	0.80	8	-501
	561				83	9.67	0.83	2	-175
	562		S		80	9.21	0.74	-1	57
	563		S		78	8.99	0.89	-3	173
	564		S		72	8.44	0.60	-5	225
	565		S		66	7.92	0.47	-7	220
	566		S		62	7.46	0.46	-10	186
	567		S		59	7.00	0.54	-14	141
	568		S		55	6.52	0.55	-29	97
	569		S		51	6.07	0.55	90	59
	570		S		47	5.59	0.58	11	30
	571		S		43	5.10	0.54	9	10
■	572	F	F		38	4.59	0.54	-1	-2
■	573	F	F		34	4.13	0.55	-9	-8
■	574	F	F		30	3.65	0.52	-5	-10
■	575	F	F	-2	26	3.14	0.50	-7	-10
■	576	F	F	0	22	2.68	0.52	-10	-8
■	577	NR	NR	0	18	2.20	0.50	-15	-6
■	578	NR	NR	0	15	1.75	0.51	-31	-4
■	579	NR	NR	1	11	1.28	0.48	-12	44
■	580	L	L	1	8	0.88	0.50	-14	124
■	581	L	L	0	8	0.59	0.54	-15	317
	582	NR	NR		122	0.67	99.00	-17	540
	583	S	S		340	1.02	99.00	-19	775
	584	S	S		900	1.53	99.00	-23	966
	585	S	S		999	2.00	99.00	-29	1073
	586	S	S		999	2.47	99.00	-38	1120
	597	S	S		999	2.91	99.00	-54	1127
	588	S	S		999	3.40	99.00	-83	1113
	589	S	S		999	3.88	99.00	-148	1089
	590	S	S		999	4.37	99.00	-343	1064

1

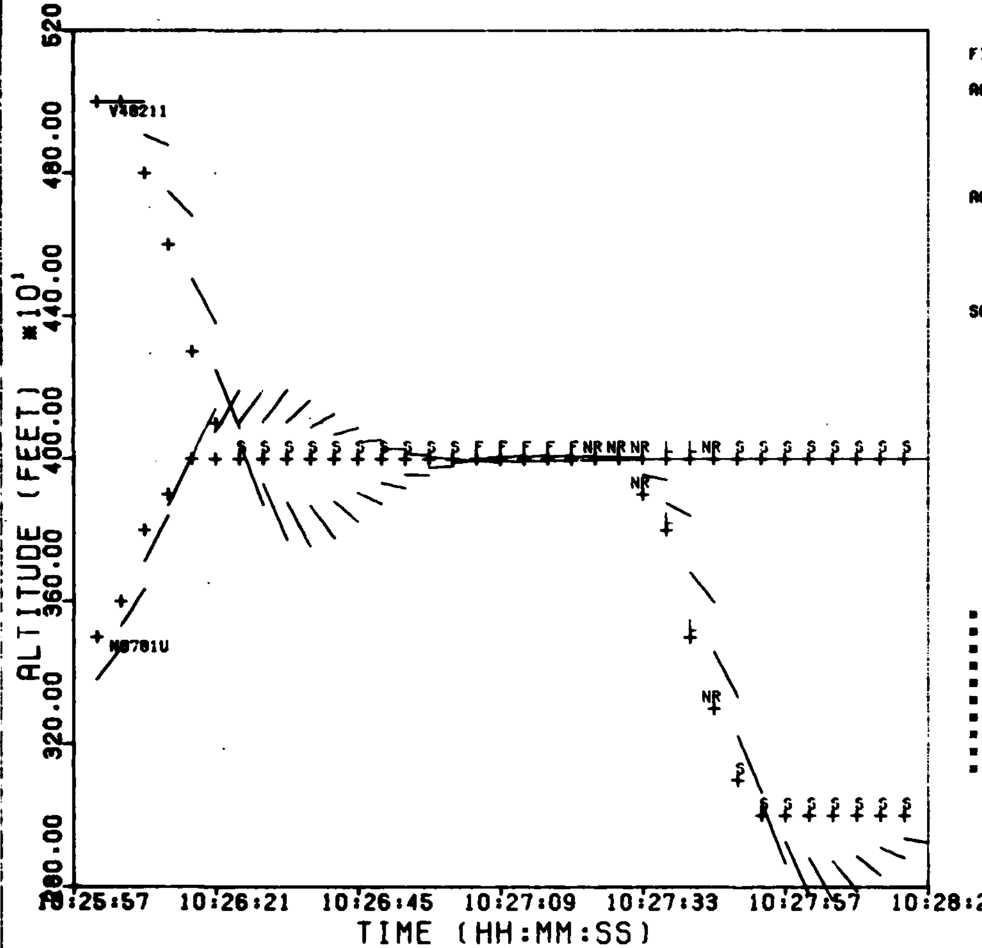
PRT/PLT ATARS 4 JUN 79 AC1 V48211 AC2 N8781U ATARS SAMPLE : PHL PD12 PSI-3

ATARS VERS. NTRC-4.5 NAFEC VERSION 2.0

START TIME = 10 26 1   END TIME = 10 28 17   ST SCAN = 556 END SCAN = 590

NPTS FT AC1 = 35   NPTS FT AC2 = 35

ENCOUNTER NUMBER 5   PSI-7



FIRST FLASHING ON SCAN 572

AC1 ID = V48211   CON DABS

X = -6.49   Y = 13.73

Z = 3998   HDG = 20

AC2 ID = N8781U   CON DABS

X = -2.46   Y = 16.93

Z = 3997   HDG = 270

SCAN	AC1	AC2	VEL1	VEL2	VRZ	DOT	TCMD
556	C	C	269	281	1296	-5190	30
557	C	C	268	258	1580	-4956	30
558	C	C	268	254	2369	-4717	30
559	C	C	269	253	3098	-4512	30
560	C	C	271	246	3908	-4288	30
561	C	C	269	241	4211	-4036	30
562	C	C	270	236	3983	-3817	30
563	C	C	268	236	3701	-3698	30
564	C	C	265	252	2796	-3660	30
565	C	C	264	263	1908	-3411	30
566	C	C	264	264	1157	-3220	30
567	C	C	264	262	588	-3008	30
568	C	C	266	259	198	-2801	30
569	C	C	263	261	-39	-2587	30
570	C	C	265	280	-161	-2380	30
571	C	C	265	280	-203	-2179	30
* 572	C	C	267	282	-196	-1980	30
* 573	C	C	268	280	-164	-1775	30
* 574	C	C	268	282	-124	-1568	30
* 575	C	C	270	282	-84	-1359	30
* 576	C	C	269	284	-61	-1150	30
* 577	C	C	268	264	-25	-938	30
* 578	C	C	265	266	-8	-729	30
* 579	C	C	266	265	218	-518	30
* 580	C	C	265	265	524	-315	30
* 581	C	C	264	264	1261	-102	30
582	C	C	262	264	1906	112	99999
583	C	C	259	264	-2409	370	99999
584	C	C	258	267	-2548	725	99999
585	C	C	261	269	-2256	876	99999
586	C	C	263	269	-1774	1090	99999
587	C	C	264	267	-1260	1270	99999
588	C	C	264	268	-804	1481	99999
589	C	C	264	268	-443	1688	99999
590	C	C	264	269	-186	1902	99999

2

PRT/PLT ATARS   4 JUN 79 AC1 V48211   AC2 N8781U   ATARS SAMPLE : PHL PD12 PSI-3

ATARS VERS. NTAC-4.5   NAFEC VERSION 2.0

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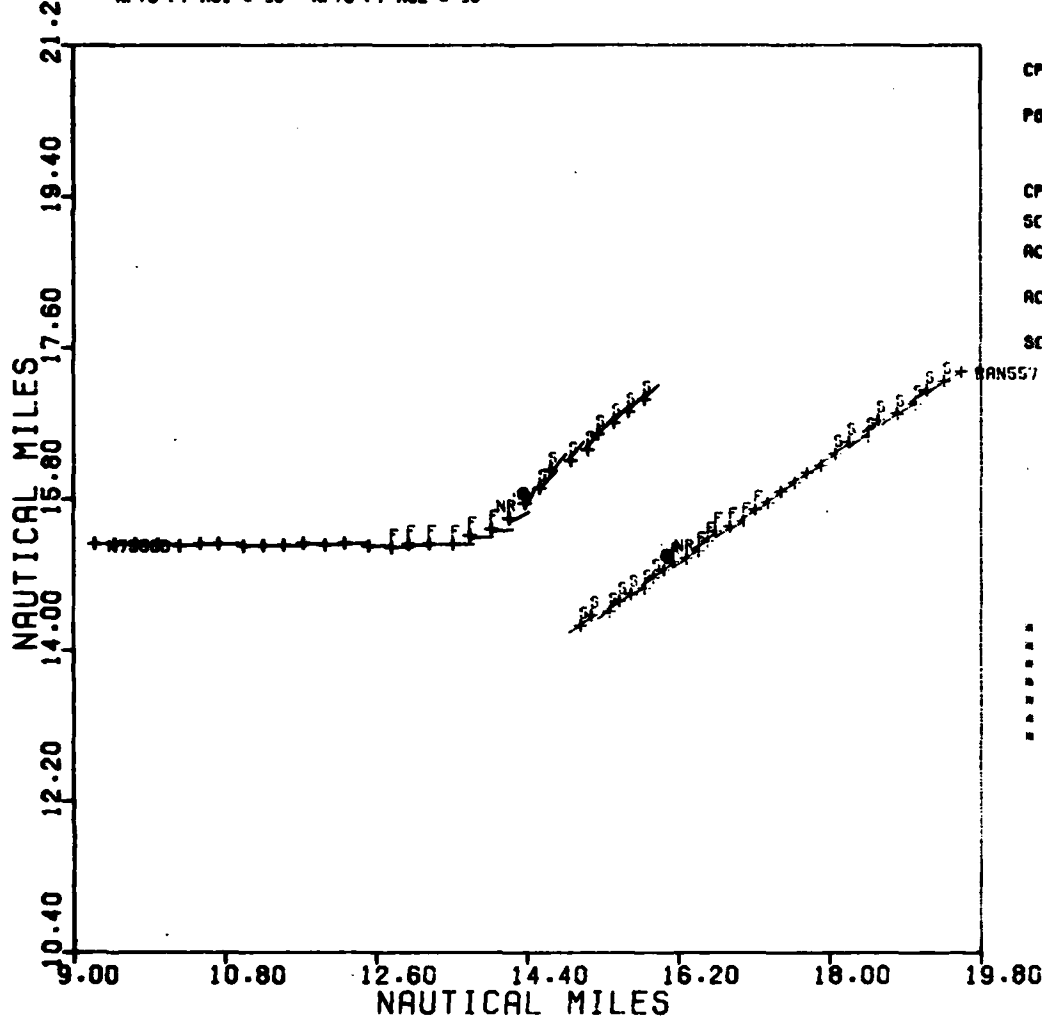
START TIME = 1? 20 42   END TIME = 10 22 38   ST SCAN = 461   END SCAN = 490

NPTS FT AC1 = 30   NPTS FT AC2 = 30

ENCOUNTER NUMBER 6 PSIV-1



PRT/PLT ATARS 4 JUN 79 AC1 N7550D   AC2 RAN557   ATARS SAMPLE : PHL PD41 PSIV-1

ATARS VERS. NTAC-4.5   NAFEC VERSION 2.0

CPAH = 1.746   CPAV = 10.427

POSCMD= 0   AT SCAN 0   MD= 0.000

ALT= 0.0   XANG= 0.00

CPA ON SCAN 494   SCPA = 1.746

SCPAH = 1.746   SCPAV = 189.594

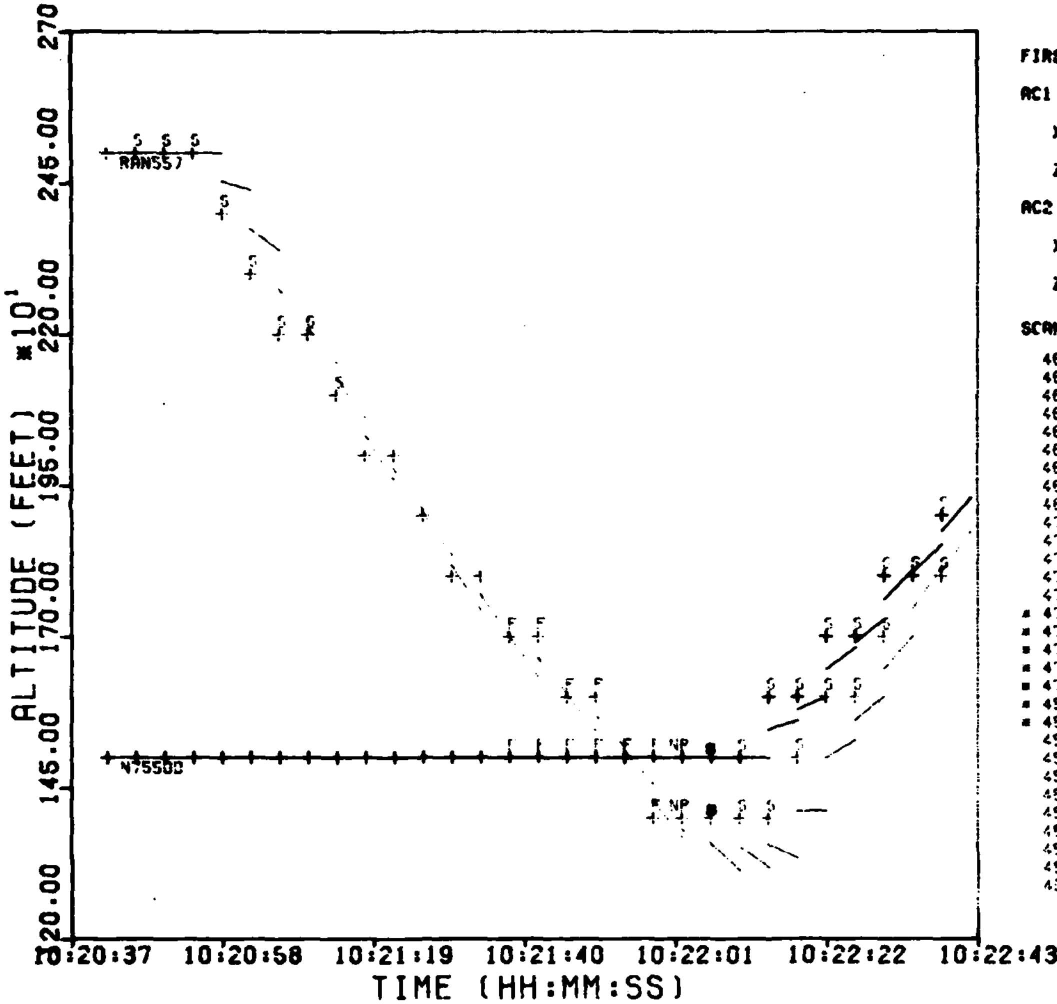
AC1 ID = N7550D   CON DABS

AC2 ID = RAN557   CON DABS

SCAN	AC1	AC2	POS	TH	RANGE	MD	TV	RZ
461				94	10.53	1.04	995	1000
462		S		90	10.09	1.04	999	1000
463		S		95	9.61	0.94	939	1000
464		S		92	9.17	1.02	969	1000
465		S		77	8.70	0.93	265	954
466		S		72	9.22	0.79	102	975
467		S		69	7.82	0.97	57	775
468		S		64	7.33	0.78	49	711
469		S		61	6.89	0.77	39	629
470				57	6.46	0.93	29	534
471				54	6.04	0.94	29	478
472				52	5.63	0.92	23	405
473				49	5.22	0.93	17	319
474				45	4.73	0.77	16	270
* 475	F	F		41	4.35	0.55	12	202
* 476	F	F		38	3.99	0.76	11	165
* 477	F	F		35	3.58	0.73	7	104
* 478	F	F		30	3.14	0.62	6	70
* 479	F	F	-2	29	2.90	0.77	1	10
* 480	F	F	0	26	2.46	0.94	-4	-70
* 481	NR	NR	0	27	2.14	1.43	-8	-117
482	●	●		57	1.89	1.79	-12	-140
483	S	S		69	1.75	1.70	-17	-145
484	S	S		999	1.75	99.00	-20	-190
485	S	S		999	1.77	99.00	-36	-169
486	S	S		999	1.83	99.00	-93	-146
487	S	S		999	2.01	99.00	399	-129
488	S	S		999	2.26	99.00	99	-114
489	S	S		999	2.43	99.00	11	-59
490	S	S		999	2.90	99.00	22	-67

START TIME = 10 20 42   END TIME = 10 22 38   ST SCAN = 461   END SCAN = 490   ENCOUNTER NUMBER 6 PSIV-1

NPTS FT AC1 = 30   NPTS FT AC2 = 30



FIRST FLASHING ON SCAN 475

AC1 ID = N755GD   CON DABS

X = 12.79   Y = 15.23

Z = 1500   HDG = 91

AC2 ID = RAN557   CON DABS

X = 17.12   Y = 15.67

Z = 1702   HDG = 235

SCAN	AC1	AC2	VEL1	VEL2	VRZ	DOT	TCMD
461	C	C	211	210	0	-4232	30
462	C	C	213	210	0	-4055	30
463	C	C	215	209	0	-3990	30
464	C	C	219	207	0	-3707	30
465	C	C	223	206	-216	-3540	30
466	C	C	225	206	-517	-3381	30
467	C	C	223	205	-919	-3171	30
468	C	C	227	203	-954	-3000	30
469	C	C	227	202	-979	-2909	30
470	C	C	227	200	-1115	-2612	30
471	C	C	225	196	-1029	-2411	30
472	C	C	225	190	-1050	-2210	30
473	C	C	223	195	-1126	-2016	30
474	C	C	226	192	-1004	-1838	30
* 475	C	C	229	177	-1011	-1669	30
* 476	C	C	227	174	-969	-1490	30
* 477	C	C	225	170	-993	-1321	30
* 478	C	C	227	166	-764	-1163	30
* 479	C	C	223	160	-906	-999	30
* 480	C	C	223	155	-929	-931	30
* 481	C	C	221	151	-950	-599	30
482	C	C	225	149	-700	-218	30
483	C	C	230	144	-513	-159	30
484	C	C	232	142	-555	-10	99999
485	C	C	232	140	-292	159	99999
486	C	C	230	141	-55	290	99999
487	C	C	226	142	19	422	99999
488	C	C	221	143	-79	556	99999
489	C	C	216	147	-314	679	99999
490	C	C	213	151	-179	920	99999

PRT/PLT ATARS 4 JUN 79 AC1 N755GD   AC2 RAN557   ATARS SAMPLE : PHL PD41 PSIV-1

ATARS VERS. NTAC-4.5   NAFEC VERSION 2.0

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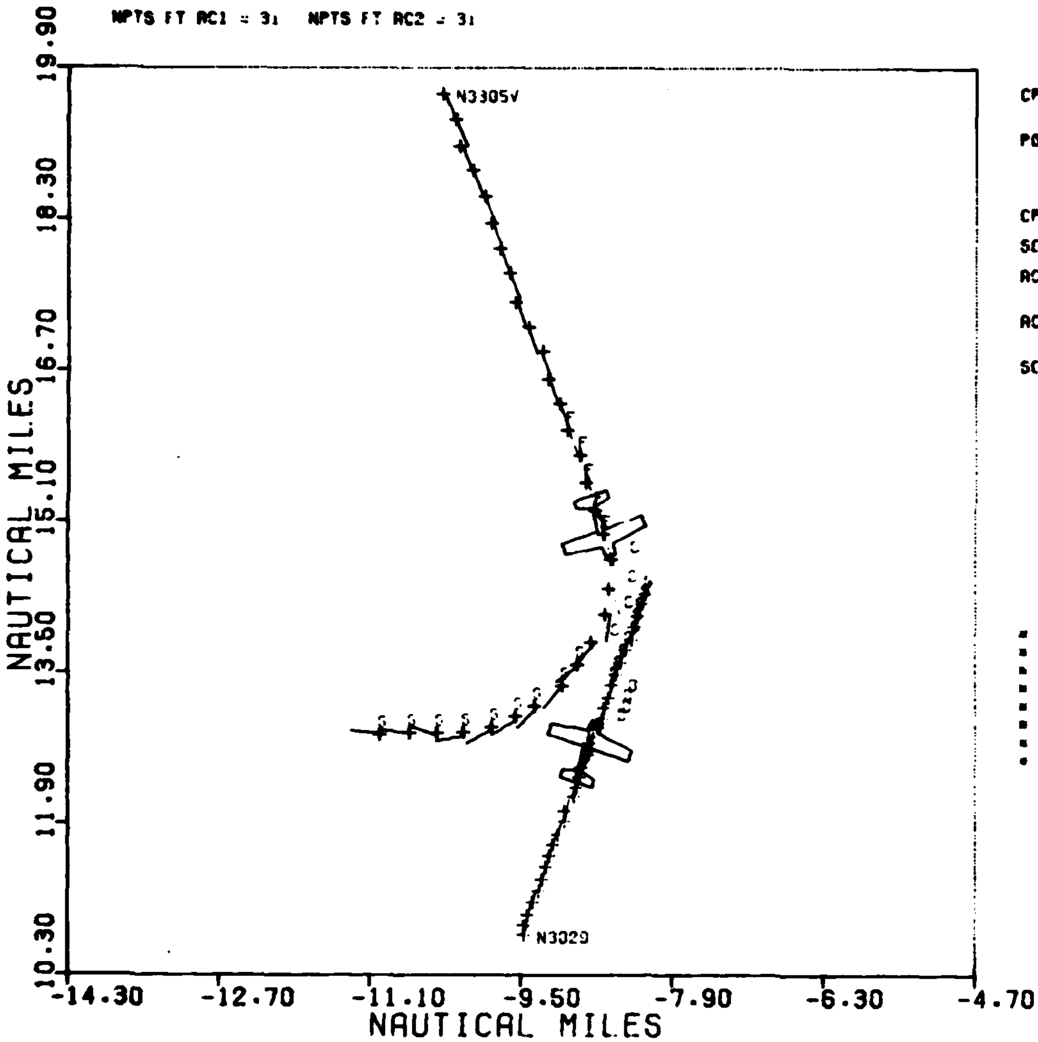
2

START TIME =   END TIME = · .3 33   ST SCAN = 774   END SCAN = 904

NPTS FT AC1 = 31   NPTS FT AC2 = 31



PRT/PLT ATARS 4 JUN 79 AC1 N3305V AC2 N3020 ATARS SAMPLE (PHL PD41 PSIV-1

ATARS VERS. NTAC-4.5 NAFEC VERSION 2.0

ENCOUNTER NUMBER 7 PSIV-2

CPAH = 0.409   CPAV = 0.133

POSCND= 1   AT SCAN 791   HD= 0.464

ALT= 3.0   XANG= 141.69

CPA ON SCAN 796   SCPA = 0.425

SCPAH = 0.408   SCPAV = 729.749

AC1 ID = N3305V   CON DABS

AC2 ID = N3020   CON DABS

	SCAN	AC1	AC2	POS	TH	RANGE	MD	TV	RZ
	774				99	9.95	0.92	13	-321
	775				95	9.56	0.91	9	-211
	776				82	9.16	0.75	4	-104
	777				79	7.77	0.70	-0	0
	779				74	7.37	0.66	-3	56
	770				70	6.96	0.55	-5	78
	780				66	6.55	0.48	-7	78
	781				62	6.17	0.46	-9	57
	782				57	5.76	0.37	-14	52
	793				54	5.37	0.39	-25	36
	784				53	4.99	0.45	259	22
	795				45	4.59	0.49	13	12
	796				42	4.17	0.43	4	4
■	797	F	F		39	3.79	0.41	-0	-0
■	799	F	F		34	3.40	0.47	-3	-3
■	799	F	F		31	3.01	0.48	-5	-4
■	790	F	F	-2	26	2.60	0.45	-7	-4
■	791	F	F	1	22	2.22	0.46	-9	-3
■	792	C	D	1	19	1.80	0.38	-13	91
■	793	C	D	1	13	1.39	0.22	-15	249
■	794	C	D	1	9	0.99	0.13	-16	449
	795	C	D		7	0.60	0.45	-19	624
	796	S	S		33	0.41	99.00	-24	729
	797	S	S		97	0.59	99.00	-31	781
	799	S	S		330	1.00	99.00	-43	797
	799	S	S		651	1.37	99.00	-64	792
	900	S	S		996	1.76	99.00	-106	776
	901	S	S		999	2.14	99.00	-215	756
	902	S	S		999	2.47	99.00	-747	738
	903	S	S		999	2.92	99.00	999	722
	904	S	S		999	3.19	99.00	572	711

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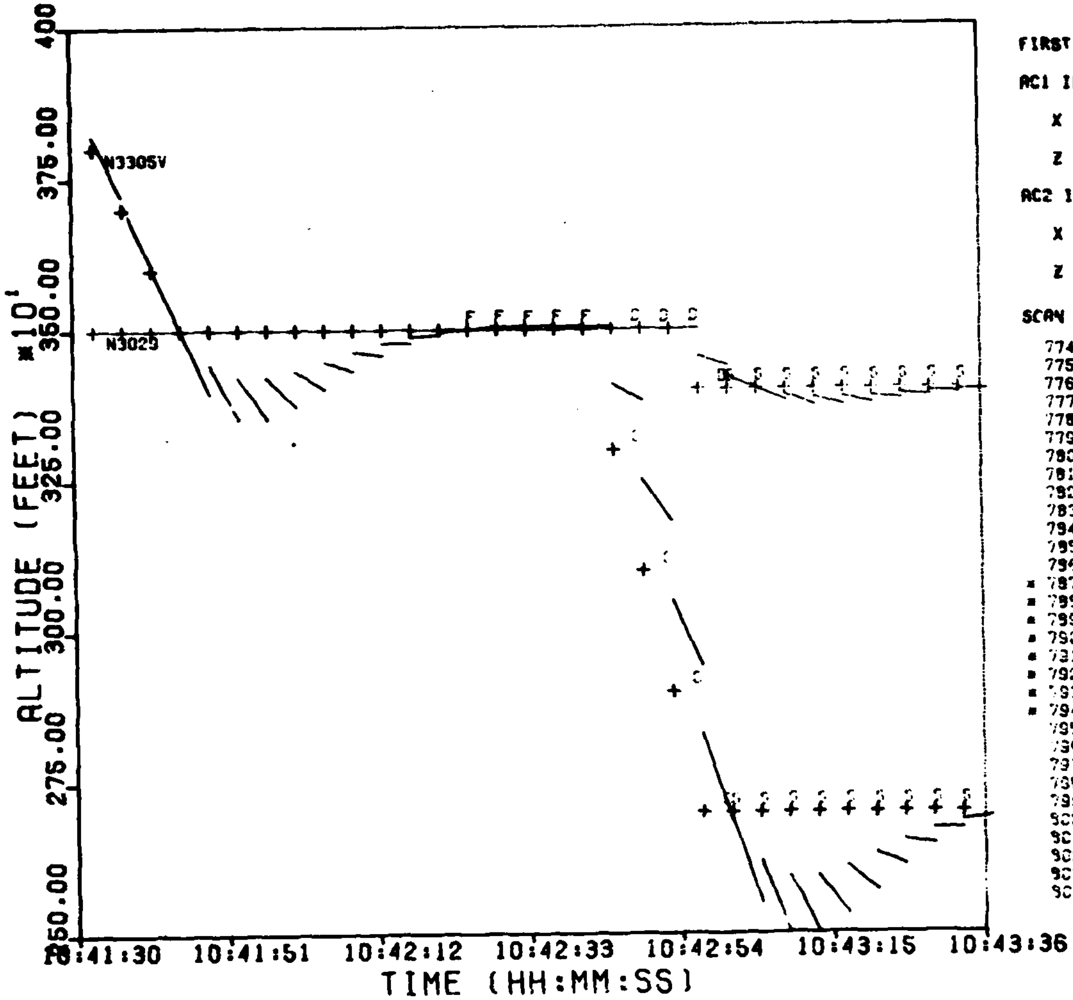
FROM COPY FURNISHED TO DDC

START TIME = 10 41 33   END TIME = 10 43 33   ST SCAN = 774   END SCAN = 804   ENCOUNTER NUMBER 7 PSIV-2

NPTS FT AC1 = 31   NPTS FT AC2 = 31



FIRST FLASHING ON SCAN 787

AC1 ID = N3305V   CON DABS

X = -9.01   Y = 16.07

Z = 3500   HDG = 160

AC2 ID = N3029   CON DABS

X = -9.30   Y = 12.29

Z = 3500   HDG = 21

SCAN	AC1	AC2	VEL1	VEL2	VRZ	DOT	TCMD
774	C	C	271	116	1505	-3231	30
775	C	C	271	115	1550	-3085	30
776	C	C	269	113	1567	-2938	30
777	C	C	266	114	1557	-2789	30
778	C	C	266	115	1341	-2643	30
779	C	C	265	115	1027	-2501	30
780	C	C	264	117	711	-2361	30
781	C	C	261	117	439	-2212	30
782	C	C	262	116	230	-2074	30
783	C	C	252	115	95	-1926	30
784	C	C	263	117	-5	-1779	30
785	C	C	263	115	-53	-1635	30
786	C	C	263	119	-71	-1495	30
* 787	C	C	262	119	-70	-135.	30
* 788	C	C	263	116	-60	-1204	30
* 789	C	C	263	112	-45	-1060	30
* 790	C	C	265	112	-31	-917	30
* 791	C	C	264	112	-19	-776	30
* 792	C	C	262	117	422	-633	30
* 793	C	C	260	119	1030	-494	30
* 794	C	C	257	117	1639	-363	30
795	C	C	261	115	1946	-150	30
796	C	C	267	115	1930	32	99999
797	C	C	270	114	1504	161	99999
798	C	C	277	114	1113	343	99999
799	C	C	273	116	743	501	99999
800	C	C	271	117	439	642	99999
801	C	C	269	119	211	737	99999
802	C	C	269	117	59	553	99999
803	C	C	270	119	-31	879	99999
804	C	C	272	116	-75	595	99999

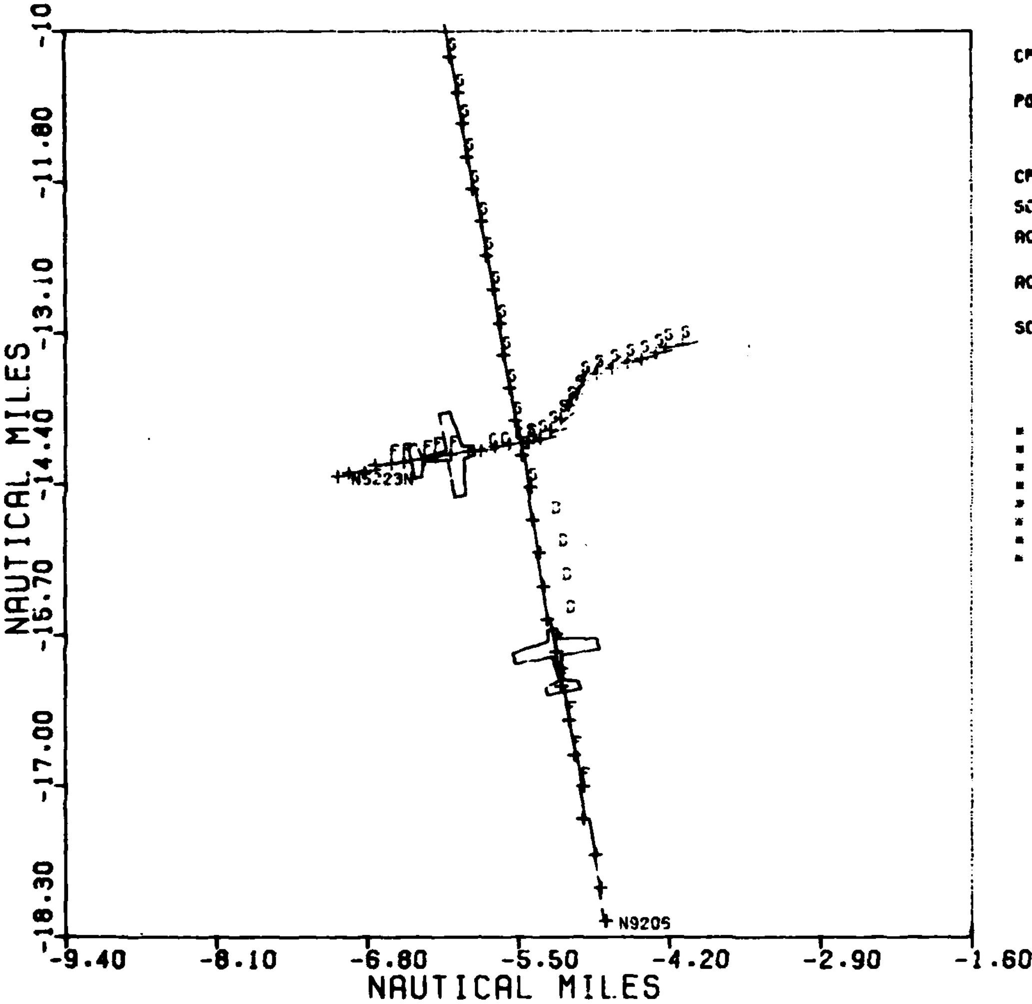
PRT/PLT ATARS 4 JUN 79 AC1 N3305V   AC2 N3029   ATARS SAMPLE : PHL P041 PSIV-1

ATARS VERS. NTAC-4.5   NAFEC VERSION 2.0

START TIME = [illegible]   END TIME = 10 33 4   ST SCAN = 535   END SCAN = 551

NPTS FT AC1 = 27   NPTS FT AC2 = 27

ENCOUNTER NUMBER 8 PSIV-5



PRT/PLT ATARS 4 JUN 79 AC1 N9206   AC2 N5223N   ATARS SAMPLE : PHL PD43 PSIV-3

ATARS VERS. NTAC-4.5   NAFEC VERSION 2.0

CPAM = 0.209   CPAV = 0.000

POSCMD= 1   AT SCAN 643 MD= 0.201

ALT= 46.4   XANG= 259.90

CPA ON SCAN 649   SCPA = 0.242

SCPAM = 0.209   SCPAV = 747.376

AC1 ID = N9206   CON CABS

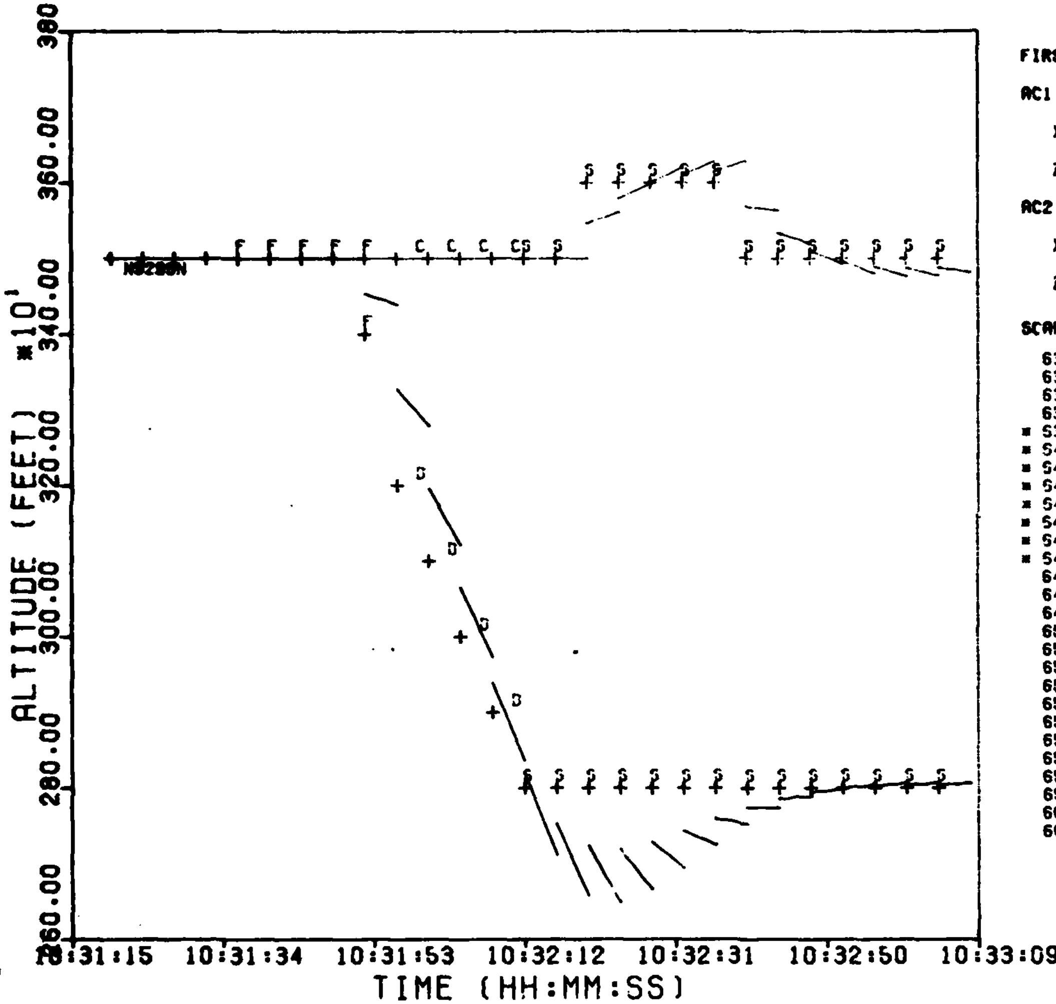
AC2 ID = N5223N   CON CABS

SCAN	AC1	AC2	POS	TM	RANGE	MD	TV	RZ
535				55	4.47	0.24	0	0
635				52	4.17	0.19	0	0
537				49	3.94	0.15	0	0
639				44	3.53	0.19	0	0
* 539	F	F		41	3.23	0.15	0	0
* 540	F	F		37	2.92	0.16	0	0
* 541	F	F		32	2.58	0.21	0	0
* 542	F	F	-2	28	2.26	0.21	0	0
* 543	F	F	1	24	1.93	0.20	-13	46
* 544	D	C	1	19	1.60	0.26	-14	172
* 545	D	C	1	15	1.29	0.23	-16	304
* 546	D	C	1	12	0.98	0.21	-19	435
547	D	C		9	0.68	0.20	-22	561
648	S	S		3	0.39	0.20	-25	590
649	S	S		-10	0.21	0.21	-31	747
650	S	S		13	0.33	99.00	-37	923
651	S	S		90	0.54	99.00	-47	960
652	S	S		157	0.73	99.00	-65	971
653	S	S		272	0.91	99.00	-97	857
654	S	S		410	1.10	99.00	-163	855
555	S	S		642	1.35	99.00	729	754
656	S	S		961	1.66	99.00	179	748
657	S	S		999	1.98	99.00	132	717
659	S	S		999	2.30	99.00	133	597
659	S	S		999	2.59	99.00	156	697
560	S	S		999	2.85	99.00	207	684
661	S	S		999	3.18	99.00	305	694

START TIME = 10 31 20 END TIME = 10 33 4 ST SCAN = 635 END SCAN = 661

NPTS FT AC1 = 27 NPTS FT AC2 = 27

ENCOUNTER NUMBER 8 PSIV-5



FIRST FLASHING ON SCAN 639

AC1 ID = N9206 CON DABS

X = -4.95 Y = -17.00

Z = 3500 HDG = 351

AC2 ID = N5223N CON DABS

X = -6.59 Y = -14.22

Z = 3500 HDG = 79

SCAN	AC1	AC2	VEL1	VEL2	VRZ	DOT	TCMD
635	C	C	263	118	0	-1296	30
636	C	C	262	117	0	-1198	30
637	C	C	261	118	0	-1104	30
638	C	C	264	115	0	-1011	30
* 539	C	C	263	115	0	-917	30
* 540	C	C	262	113	0	-824	30
* 541	C	C	262	116	0	-734	30
* 542	C	C	263	116	0	-645	30
* 543	C	C	264	116	216	-554	30
* 544	C	C	264	118	733	-460	30
* 545	C	C	264	117	1120	-369	30
* 546	C	C	263	117	1382	-278	30
647	C	C	263	115	1540	-188	30
648	C	C	261	118	1619	-95	30
649	C	C	260	117	1428	-10	30
650	C	C	260	114	1336	71	99999
651	C	C	260	112	1094	115	99999
652	C	C	260	113	807	107	99999
653	C	C	259	115	537	157	99999
654	C	C	259	117	315	188	99999
655	C	C	260	116	-65	244	99999
656	C	C	261	113	-260	385	99999
657	C	C	262	116	-327	600	99999
658	C	C	261	120	-315	653	99999
659	C	C	261	122	-264	741	99999
660	C	C	259	119	-198	799	99999
661	C	C	260	119	-135	893	99999

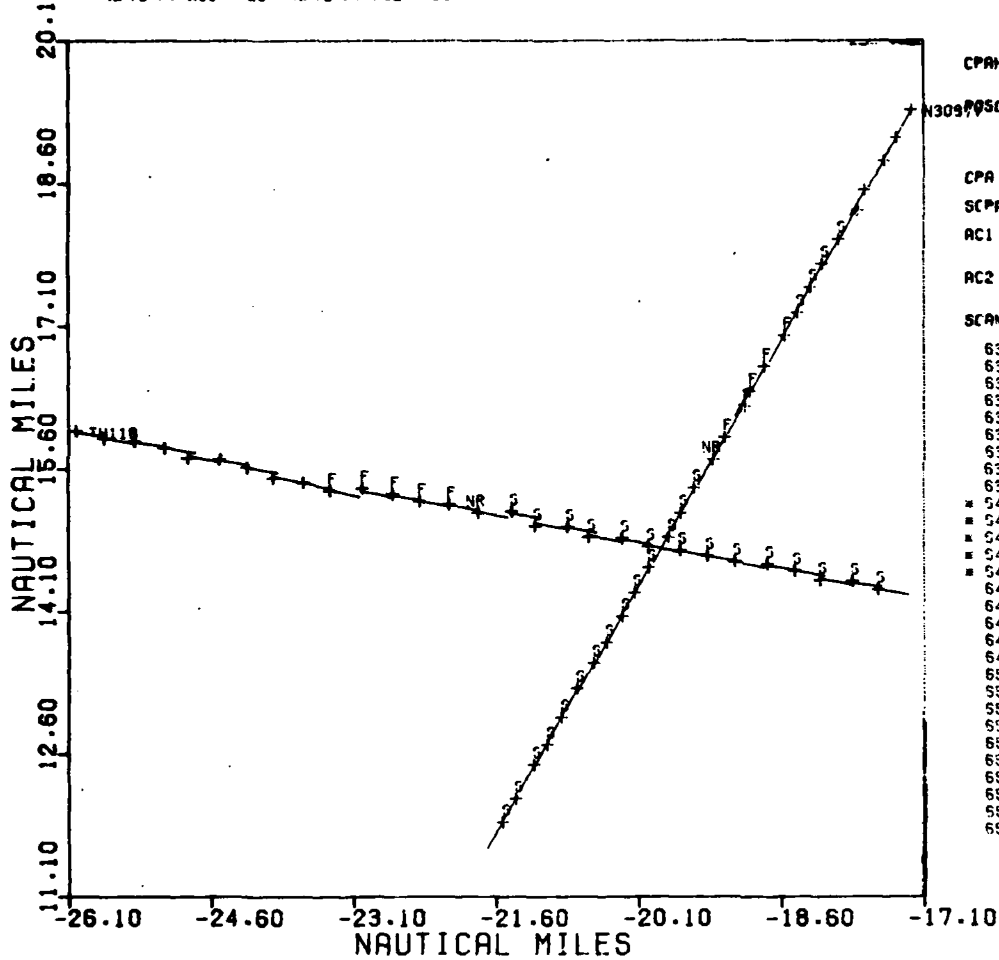
PRT/PLT ATARS 4 JUN 79 AC1 N9206 AC2 N5223N ATARS SAMPLE : PHL P043 PSIV-3

ATARS VERS. NTRC-4.5 NAFEC VERSION 2.0

2

START TIME = [illegible]   END TIME = 10 33 53   ST SCAN = 631   END SCAN = 659   ENCOUNTER NUMBER 9 PSIV-7

NPTS FT AC1 = 29   NPTS FT AC2 = 29



CPAH = 0.576   CPAV = 424.862

POSCMD= 0   AT SCAN 0   MD= 0.000

ALT= 0.0   XAMO= 0.00

CPA ON SCAN 650   SCPA = 0.592

SCPAH = 0.576   SCPAV = 503.360

AC1 ID = TH118   CON DABS

AC2 ID = N3087V   CON DABS

SCAN	AC1	AC2	POS	TH	RANGE	MD	TV	RZ
631				74	9.44	0.56	48	-1200
632				70	8.93	0.60	44	-1100
633				65	8.42	0.64	40	-1000
634				61	7.87	0.64	35	-900
635				59	7.46	0.56	32	-800
636		S		55	6.93	0.61	28	-700
637		S		51	6.42	0.56	24	-600
638		S		48	5.98	0.46	20	-500
639		S		45	5.49	0.45	21	-446
* 640	F	F		42	5.04	0.40	26	-425
* 641	F	F		36	4.46	0.53	37	-425
* 642	F	F		31	3.93	0.57	62	-435
* 643	F	F	-2	29	3.53	0.50	123	-450
* 644	F	F	0	24	3.00	0.55	344	-466
645	NR	NR		21	2.53	0.51	999	-479
646	S	S		16	1.97	0.56	-591	-489
647	S	S		12	1.53	0.52	-440	-496
648	S	S		9	1.07	0.54	-448	-500
649	S	S		7	0.70	0.55	-528	-502
650	S	S		78	0.59	99.00	-693	-503
651	S	S		187	0.90	99.00	999	-503
652	S	S		501	1.23	99.00	999	-503
653	S	S		945	1.66	99.00	999	-502
654	S	S		999	2.13	99.00	999	-502
655	S	S		999	2.67	99.00	999	-501
656	S	S		999	3.17	99.00	999	-500
657	S	S		999	3.60	99.00	999	-500
658	S	S		999	4.17	99.00	999	-500
659	S	S		999	4.65	99.00	999	-500

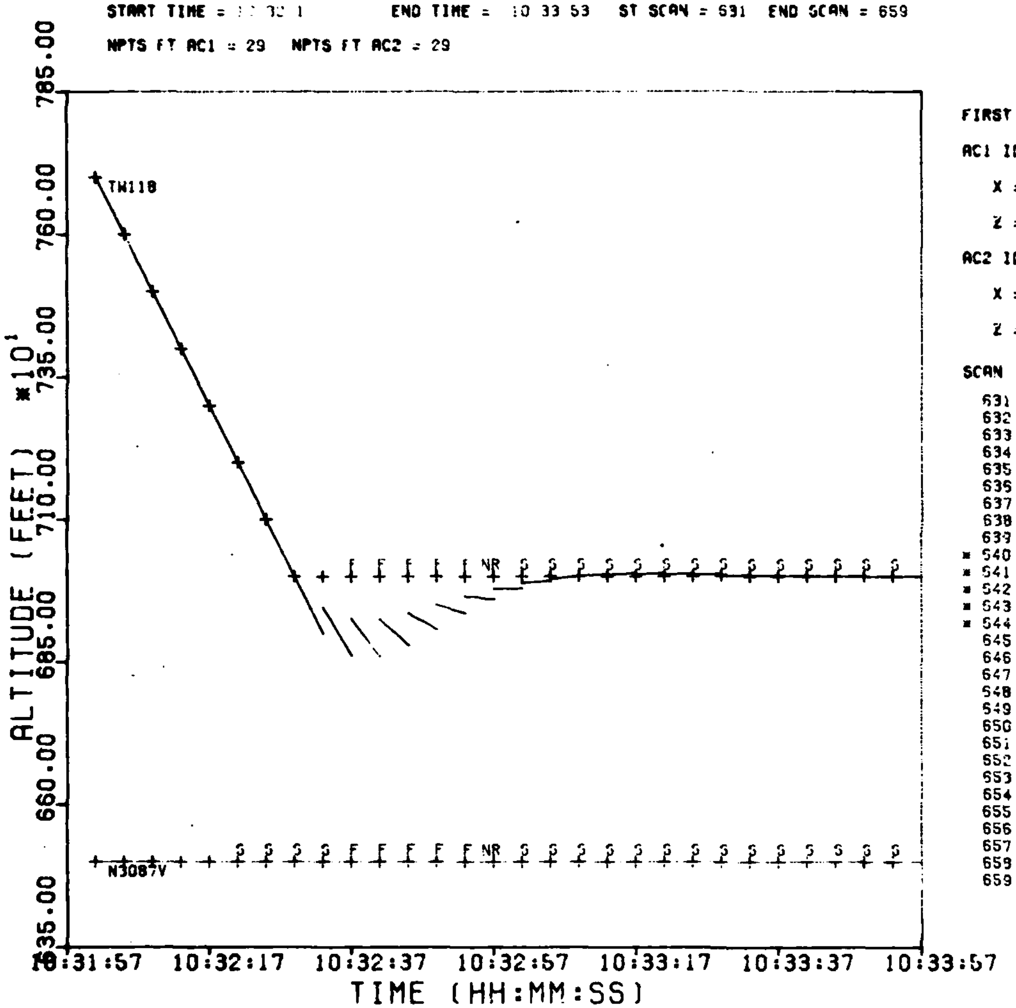
PRT/PLT ATARS 4 JUN 79 AC1 TH118   AC2 N3087V   ATARS SAMPLE : PHL PD44 PSIV-4

ATARS VERS. NTRC-4.5   NAFEC VERSION 2.0

START TIME = [illegible] END TIME = 10 33 53 ST SCAN = 631 END SCAN = 659

NPTS FT AC1 = 29 NPTS FT AC2 = 29

ENCOUNTER NUMBER 9 PSIV-7



FIRST FLASHING ON SCAN 640

AC1 ID = TW118 CON DABS

X = -23.34 Y = 15.39

Z = 6925 HDG = 103

AC2 ID = N3097V CON DABS

X = -18.56 Y = 16.99

Z = 6500 HDG = 209

SCAN	AC1	AC2	VEL1	VEL2	VRZ	DOT	TCMD
631	C	C	285	276	1499	-4327	30
632	C	C	285	280	1499	-4122	30
633	C	C	295	279	1500	-3894	30
634	C	C	286	284	1500	-3582	30
635	C	C	282	278	1500	-3399	30
636	C	C	281	280	1500	-3159	30
637	C	C	280	280	1500	-2922	30
638	C	C	277	278	1500	-2671	30
639	C	C	277	275	1284	-2430	30
* 640	C	C	276	271	983	-2192	30
* 641	C	C	276	276	681	-1979	30
* 642	C	C	278	278	420	-1766	30
* 643	C	C	278	267	220	-1550	30
* 644	C	C	278	269	81	-1321	30
645	C	C	279	266	-5	-1104	30
646	C	C	282	270	-50	-863	30
647	C	C	280	273	-69	-651	30
648	C	C	282	273	-67	-422	30
649	C	C	276	280	-57	-198	30
650	C	C	276	283	-44	48	99999
651	C	C	275	282	30	258	99999
652	C	C	276	282	18	497	99999
653	C	C	276	277	10	707	99999
654	C	C	275	275	4	925	99999
655	C	C	277	277	-0	1188	99999
656	C	C	278	280	-2	1425	99999
657	C	C	275	276	-3	1599	99999
659	C	C	275	283	-3	1899	99999
659	C	C	274	284	-2	2096	99999

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ATARS VERS. NTRC-4.5 NAFEC VERSION 2.0

GLOSSARY

ALARM	An ATARS message consisting of an FPWI and/or command
BADCOM	A candidate aircraft cockpit display for displaying ATARS messages to the pilot
CPA	Closet point of approach
CPAH	Horizontal CPA
CPAV	Vertical CPA
DATA BLOCK	That grouping of operational data, e.g., ACID, SPEED, ALTITUDE, associated with in aircraft target and displayed to the controller on his PVD.
DESENSITIZATION	Suppression of some ATARS data link information (FPWI and/or command) to the aircraft and ATC facility when the aircraft is located within a specified three dimensional zone and meets specified operational conditions.
ENCOUNTER	Exists whenever ATARS issues a message (OPWI, FPWI, or command) to one or more aircraft.
EQUIPPED	The status of an aircraft that has a DABS transponder with altitude encoder and a cockpit display for ATARS messages.
FAZ	Final approach zone within which the ATARS was desensitized.
FPWI	Flashing proximity warning indicator (See appendix B)
MD	Miss Distance--The projected CPA between an aircraft pair in the horizontal plane

Negative resolution advisory or command (see appendix B).

OPWI	Ordinary proximity warning indicator (See appendix B)

Positive resolution advisory or command (see appendix B).

SATELLITE AIRPORT	An airport other than the primary airport associated with an ATC facility for which that ATC facility assumes the responsibility for the control of aircraft operating under instrument flight rules.

SCAN	One complete 360° rotation of the DABS antenna (4 seconds)
SCPAH	Horizontal separation at slant range CPA
SCPAV	Vertical separation at slant range CPA
TCA	Terminal Control Area—Controlled airspace extending upward from the surface or higher to specified altitudes within which all aircraft are subject to operating rules and pilot and equipment requirements specified in FAR Part 91.
TH	Modified horizontal tau (See appendix B)
TRACON	Terminal Radar Control Facility
TRSA	Terminal Radar Service Area—Airspace surrounding designated airports wherein ATC provides radar vectoring, sequencing, and separation on a full time basis for all IFR and participating VFR aircraft.
T_V	Time to coaltitude for a pair of aircraft (See appendix B)
UNEQUIPPED	In ATARS terms, the status of an aircraft that has an ATCRBS transponder with an altitude encoder but no capability to receive or display uplinked data from ATARS.
VECTOR LINE	A display technique used on a controllers PVD to indicate the projected track of an aircraft target. The vector line is controlled in length by a system parameter time, e.g., 60 seconds.


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